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ABSTRACT

Research was conducted invclving a three-day workshop model. The first day of the workshop involves a sessicn on a college campus for science teachers and sccial studies teachers and students for the purpose of developing understanding of environmental problems. The second day is conducted at the high school; teachers and students who attended the first session act as discussion leaders for larger groups of students. The third phase consists of a return to the campus of the original group of teachers and students to review data collected on an envircnmental probler identified in the high school session. This report evaluates the effectiveness of the workshops in producing changes in students participating in the workshops and in the curricula of schools sending participants to the workshops. (RE)

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DEMONSTRATION AND EVALUATION OF BENEFITS AND EFFECTIVENESS OF A MODEL FOR STUDENT PROJECTS IN ENVIRONMENTAL PROBLEM ANALYSIS

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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A Technical Report Submitted to the

NATIONAL SCIENCE FOUNDATION

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INTRODUCTION TO THE STUDY

CHANGES IN SCHOOLS

Changes in the teaching learning process occur slowly in American schools. Major federally funded efforts to revise curricula and to train teachers during the 1950's and 1960's, while successful in many areas, appear to have given way to a much more conservative approach in the 1970's in which the schools pursue their own development work or work cooperatively with a university to produce the desired change. The impact of the curriculum development-training efforts of the past 20 years is only now being assessed (NSF, 1975). Already there is a need for changes in the school science curriculum but a systematic mechanism for encouraging this change has not yet emerged (Ost, 1975; O'Hearn, 1976).

The University of Wisconsin-Green Bay has developed a model for implementing environmental problem-focused activities at the high school level through a series of workshop activities sponsored cooperatively by the university and by schools. This model requires a low commitment of cost but a high commitment of effort and involvement and offers one systematic means of helping schools help themselves.

THE GREEN BAY WORKSHOP PLAN

The workshop plan can be summarized as follows:

> "The Workshop Plan consists of three segments. The first part consists of a one-day invitational session on the University campus for high school students and teachers. Each school is encouraged to send two teachers, usually a science and a social studies teacher, and three students who will function as a team. A one-day session avoids problems of lodging and associated expenses. The objective of this initial one-day session is to develop understanding of the selected environmental problem and to develop a strategy for gathering data about the problem within the home high school community. Care must be taken so that the high school teachers are fully cognizant of the objectives of the workshop, the problems and pitfalls to be associated with the collection procedure and the long-term objectives and opportunities for them to incorporate some of these materials into their ongoing disciplinary-based high school instructional programs. The teachers must honestly feel that they are an integral, vital part of the workshop, and not merely a transportation mechanism to bring students to the campus.

"The second phase of the workshop is carried on in the local high school. The teachers can expand or diffuse the monitoring effort to larger groups of students, usually entire classes, with those students who attended the campus workshop serving as leaders. The activity consists, primarily, of data collection associated with preliminary or partial summary and analysis of these data and the transmission of these data to the campus for detailed summary, analysis and interpretation. During the in-school phase, the high school teacher is the source of authority and information. It is during this phase that additional help and materials from the University may make the difference between a successful learning experience with potential for long-term payoff, and a routine data collection exercise. The teacher should have full knowledge of the intent and the operation of the project and should be able to easily contact the University for follow-up information and/or materials. It is in this stage that the design of the data collection procedures becomes crucial. If these procedures disrupt the normal classroom activity or require an excessive commitment of the teacher's time, then trouble is assured. It is also during this time that the teacher can and should start to integrate such science project activities into the ongoing science curriculum.

"The third phase consists of a second day on campus when the same team of teachers and students assemble to review the results of the analyses of the data, which have now been pooled and systematically displayed. This discussion should lead to the development of alternative solutions to the problem and it should involve the discussion by representatives of other disciplines and agencies in seeking answers. At this point, social scientists, public health personnel and others brought together can contribute to the discussions.

"It is crucial that both the students and the teachers feel that they have had a significant part in the development of these results and that they have a significant voice in the discussion and the interpretation of the results. One-way communication via the lecture format will not work.

"The problem selected as the central focus of the workshop should have direct relevance to the school-aged population and be amenable to collection of data in a meaningful way by high school-aged students. These environmental problems should cut across the usual disciplines of chemistry, physics, biology, mathematics, economics, political science and sociology and build on the 'certified knowledge' and methods of these disciplines. Students and teachers should be encouraged to seek the help and advice of professionals in these areas as appropriate. Of course, the University can serve as an operational model by bringing together these experts during the introductory phase of the program. This approach should prompt students to formulate and visualize alternative kinds of solutions to their selected problems. The students explore what might happen as each of the alternatives is implemented. By this means they develop the facility for formulating meaningful questions in their search for new information and projections of their solutions. 'Right answers' are seen in the light of the constraints

and the long-term impact. Solutions which are finally adopted are viewed as 'optimum' rather than in simple agreement with a textbook or answerbook. The Workshop Plan prompts students to ask 'what ought to be in the future' rather than the more usual question of what occurred in the past. The plan calls for hands-on involvement in problems that cannot be 'solved' in the classroom sense but which must be resolved in the real world context. In short, the approach calls for students to explore problems, making use of certified knowledge and paradigms of the natural sciences and social sciences. This procedure encourages students to examine and evaluate the possible consequences of their actions before detrimental results occur from well intentioned but wrong choices.

"The impact of this three-part program needs to be emphasized. The essential ingredients for orderly change are present in the model. The local school administrators by virtue of their agreeing to let their students and teachers participate in the program, have given tacit approval to changes which might occur as a result of the program. This is reenforced by the financial commitment for transportation and substitute teachers. An emotional commitment on the part of teachers is obviously present too, since they have agreed by their own choice to take part in the workshop. The potential for change applies equally well to the University, where faculty from the several departments have direct contact with high school students and teachers."

PURPOSE OF THE STUDY

The purpose of this evaluation project was to determine the effectiveness of the environmental problem workshops in terms of success in producing changes in (a) students who participated directly in workshop activities and (b) the curricula of those schools sending participants (students and teachers) to the workshops.

--Impact on Students

There were three areas of dependent variables for students: approaches to problem analysis, interest in science and knowledge of environmental topics. For both the students participating directly in workshops and for the students in the schools known as the primary diffusion group, the workshops were to (a) improve the effectiveness with which students approach problems, particularly problems of an environmental nature, (b) increase the student interest in science and (c) increase student knowledge of environmental topics. This evaluation was

designed to determine the effectiveness of the workshop in achieving changes in students in these areas.

--Impact on Schools

For schools, the critical, dependent variable is the school curriculum. The workshops were to increase the frequency of problem-oriented offerings in environmental problem areas. This study was designed to determine the degree to which teachers in the project, adopted problem-oriented strategies in their classes in ways which were related to workshop activities and objectives and to obtain other evidence of lasting effects of the project on the project teachers, other teachers and the school curriculum in terms of specific examples. The design also called for obtaining evidence of diffusion of interdisciplinary approaches within the schools in terms of the use of science projects and problem approaches in teaching, the use of school and community resources and the development of problem-focused interdisciplinary curricula. Also to be determined was the dependence of the project's success on university personnel and support as well as indications of limitations within the schools or the workshops, which inhibit project activities.

ORGANIZATION OF THE STUDY

The study was under the direction of the principal investigator aided by an advisory committee which included the administrator in charge of off-campus activities, the coordinator of high school workshops, the director of the educational testing program, the project teacher, the chairperson of the Department of Education and four faculty members directly involved with workshop activities. The committee functioned throughout the duration of the investigation providing insight and advice to the director on the development of the project and the interpretation of the resultant data.

DESIGN AND METHODS

The intent of the study was to assess the impact and operation of the Green Bay workshops in terms of benefits to students, to teachers and to the university. The study was divided into two major components: (1) a student-based experimental study and (2) an in-school study of teachers, programs and teachers' perceptions of changes in students. The student-based study focused on those students associated with the solid waste workshop conducted in the Fall of 1974-75, while the in-school study, which used the case study method, focused on teachers who had taken part in previous workshops.

DESIGN OF EXPERIMENTAL STUDENT STUDY

The design of the student-based portion of the evaluation was of the experimental-control, pretest-posttest variety. Dependent variables included five measures relating to the areas of intended impact of the workshop. These measures are described in the "Instruments" section below. Procedures for pre- and posttesting are described in the "Data Collection" section below. Since the experimental and control groups were determined by voluntary cooperation rather than by random assignment, the design would have to be classified as a quasi-experimental, at best, rather than a true experimental design. The composition of the experimental and control groups is described in the "Student Groups" section below.

--Instruments and Methods of Analysis

Evaluation of the impact of the workshops on students employed five instruments: an academic interest measure, a problem-solving attitude scale, a test of knowledge about solid waste management, a career choice index, and the problem-solving skills question generation technique. The academic interest, problem-solving attitude, and career choice measures were identical in the pretest and posttest. The knowledge test and question generation materials

were designed to be different but equivalent forms of each measure. Responses to all measures, except the question generation technique, were recorded by students on a machine scannable answer sheet. It should be noted that the instruments employed in the evaluation were designed for analysis of group results, not for reporting individual scores. Therefore, the instruments did not have to be as lengthy as tests used for purposes of individual assessment.

--Academic Interest Measure

Students indicated their interest in ten areas in which they might take courses in school: Art, Music, English, Science, Business, Mathematics, Home Economics, Social Studies, foreign language, Industrial Arts (Shop). Responses were made on a three-point scale: Like, Not Sure, Dislike. Previous research, while not in universal agreement on the point, suggests that use of the three-point scale is as adequate as more extensive scale distribution (e.g. Masters, 1974; Komanta and Graham, 1965). It has also been found that the simple, direct question about interest in specific school subjects yields results highly comparable with more detailed, extensive methods for measuring interests at the high school level (Katy, Norris and Halpern, 1970; Norris and Katy, 1970).

The variable of primary concern among the ten interest items was the student's interest in science. However, a total interest measure was also obtained by summing a student's responses across the ten school subjects. Responses to individual subjects as well as to the total set of subjects are reasonably reliable and relatively free of an acquiescence response bias as indicated by correlations of the responses to the same subject of about .60 over the year and intercorrelations among responses to different subjects approaching .00.

Responses to the interest items were scored: 1 = Like, 2 = Not Sure (or omit), and 3 = Dislike. Therefore, a low score on the interest items indicated a favorable attitude.

--Problem-Solving Attitude

Students' attitudes towards problem solving were assessed using a modified version of Carey's (Shaw and Wright, 1967) Problem-Solving Attitude Scale. Carey had two equivalent, 18-item, five-point Likert-type scales. Shaw and Wright (1967, p. 268) state of the Carey scale: "This seems to be a relatively reliable instrument for measuring attitudes toward problem solving. It is average or above in demonstration of validity. The referrent chosen for the scale is unique and should provide interesting information in future research." Drawing primarily from these items (with the author's permission) and adding several locally-developed items, a ten-item, three-point Likert-type scale was constructed. The scale appeared to have acceptable internal homogeneity as indicated by an average item-total score correlation of about .40 (determined on the total groups used in this project). The scale also showed adequate stability, $r = .57$, from beginning to end of the year. Exactly what is measured by the scale is probably best indicated by the two items with the highest correlation with the total score on the scale. These items are 13 and 17 (in the test booklets in the Appendix): "I like games which involve solving problems," and "I'd rather play games which are just fun than ones which make you think." The latter item, as well as three other items in the scale, were intended to be scored negatively, i.e. response values were reversed when combined with other responses.

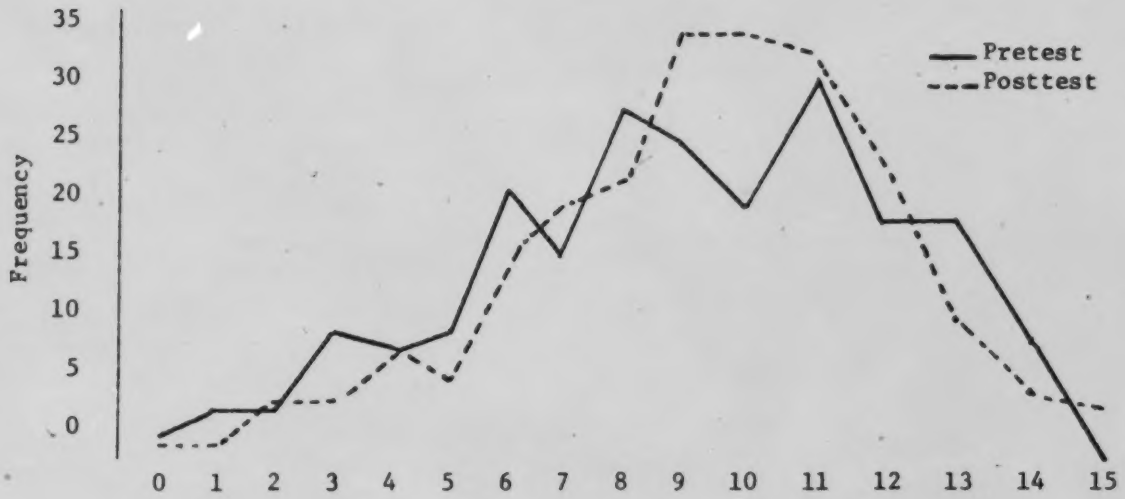
--Knowledge of Solid Waste

Two equivalent forms of a test of knowledge about solid waste were locally constructed specifically for this project. Each form contained 15 items. Originally, a pool of approximately 40 items was developed and edited by project staff. Items were written to have varied difficulty levels for the target group and to provide balanced coverage to different aspects of the solid waste topic (sources,

composition, disposal, social impact, etc.). From the original pool of items, 15 pairs of items were formed based on similarity of content. One item from each pair was randomly assigned to the pretest, the other being allotted to the posttest. For a short test, this instrument appeared to have acceptable psychometric properties. Distribution of raw scores on the two forms, based on a randomly-selected sample of 200 students in this project, are shown in Figure 1. Both forms appear to have adequate "ceiling" for the assessment of even the most knowledgeable students, while still having only a small percentage of students (10 - 15 percent) performing at or below a chance level.

FIGURE 1

Distribution of Raw Scores



Correlation between scores on the two forms of the test from beginning to end of the year was .59 in one project group and .48 in another group. Saupe's estimate of reliability for the two forms of the test ranged from .52 - .69. Using Johnson's Upper-Lower Index (ULI) (Guilford, 1954) as a measure of item homogeneity, no items with negative ULI's were obtained and a median ULI of approximately .28.

--Career Choice

Students were asked to indicate their first, second and third career choices from a list of 99 careers grouped into 14 categories. For purposes of data analysis in this project, these responses were converted into a simple 0-1 scale, where 1 meant that the student selected some career in Environmental Management or Environmental Science at least once among his or her first, second or third choices and 0 meant that the latter condition was not met. (Students who failed to indicate all three choices on both pre- and posttest were eliminated from these analyses.)

Inspection of the test booklet will reveal that students were also asked to indicate whether they intended to go to college or to vocational-technical school. Given the structure of this question, and its placement in the booklet, it could not be determined whether a student who did not mark anything for this question (a) did not intend to pursue either type of postsecondary education or (b) never read the question. Consequently, no analyses of these questions were conducted.

--Problem-Solving Skills

In order to investigate certain aspects of problem-solving skills, a question generation technique was employed. Students were given a topic or problem (air quality for the pretest, energy uses in your community for the posttest) and asked to write as many questions as they could think of relating to the problem; students were given five minutes to write their questions.

The technique is similar to the unusual uses, unusual questions, new uses and other associational fluency tests by Guilford (e.g. 1967) and Torrance (1964).

Questions written by students were scored in two ways. First a total score was obtained by counting all of the questions written by a student.

A minimum quality check was applied before obtaining the total count to exclude questions which were obviously frivolous, completely unrelated to the topic, or repetitious of exactly the same question. Such exclusions amounted to slightly less than 10 percent of all the questions listed.

The second type of score obtained for the questions was based on a categorization of the questions along two dimensions. First, each question was classified as to whether it dealt primarily with social-economic-political or scientific-technological aspects of the topic; a third category along this dimension was simply "other" or "general," i.e. the question was classified as to whether it dealt primarily with matters of extent, measurement, production of the problem or was oriented toward solutions, remedies for the problem.

Scoring of the questions was conducted by four upper division college students working under the supervision of project staff. The scorers were given a training session prior to the scoring of student responses actually used for analyses in this report. The training session consisted of: (a) explanation of the scoring scheme, (b) actual scoring of samples of question sheets from the project independently by pairs of scorers, (c) discussion among scorers of differences in their application of the scoring scheme, and (d) scoring an additional sample of question sheets. Data from this final step served as a basis for checking the reliability of the scorers in their use of the classification scheme. All four scorers scored a sample of 50 question sheets. The category assignments (six in all) made by the scorers on the second and the penultimate question on the sheet were selected for analysis. Comparison of the categorizations showed that among the six possible pairs of scorers, there was exact agreement on the classification of the questions in 70 percent of the instances, which is a very respectable level of agreement. Among the disagreements, the great majority showed agreement in classification along one dimension but not

the other. Disagreement in classification on both dimensions was rare.

The total number of questions generated by each student showed very modest stability as indicated by correlation between pre- and posttest scores; ($r = .48$ in one sample and $r = .29$ in another) and its relationship with the other measures used in this project tends to be low. Perhaps the most interesting aspect of the question generation data, apart from their relevance to the evaluation, is the small number of questions which students were able to generate. Averaging across groups and testing periods, the average number of questions generated about these topics of current interest was only about five, representing a distressing lack of verbal-ideational fluency.

--Population of Student Groups and Data Analysis

The experimental design called for finding evidence of success in producing changes in student participants directly involved in the workshop. The design also called for finding evidence of change in "diffusion" students, who were associated with the workshop data collection activities within the schools, but not active participants in the on-campus sessions.

The population samples were selected as follows: student participants from the 25 schools who took part in the Fall 1974 workshop on solid waste problems formed the experimental group. The diffusion group was defined as a minimum of one class and a maximum of two classes (each of approximately 25 students) identified by the classroom teacher as data collecting participants within the school. The control schools were selected on a paired basis with the experimental schools, using the criteria of general geographic location, urban versus nonurban, comparable school enrollment and general socioeconomic levels. It should be noted that the matching technique used in selecting the control school population will not enter into the analysis of the data, but was used merely to insure that the control schools and students were comparable to the schools and

students participating in the workshop and included in the evaluation. Of the control schools identified, 22 agreed to take part in the study. It was felt that this number would insure an adequate final population for comparison purposes.

Within the control schools, a subgroup of students to serve as the primary control group was obtained by asking teachers of control classes to provide the names of four students whom they would nominate to take to a workshop, given the opportunity.

A total of approximately 1,800 students from 75 classes in 47 different schools (25 experimental schools and 22 control schools) participated in the evaluation, although not all students were involved in all the analyses, as described below. Students were divided into experimental and control groups and within each group, further subdivided into "primary" and total groups. Included within the experimental group were students in 50 classes from 25 school systems scattered throughout the state, whose teachers directly participated in the workshop during the 1974-75 academic year. Each participating teacher was accompanied by two students who took part in all workshop activities. These students were referred to as the primary experimental group; they were distinguished from the total experimental group for purposes of data analysis since it was expected that the workshop would have a more pronounced effect on them due to their more intensive involvement.

Although the primary experimental and primary control groups were analyzed separately from the total group, they were also included with the total group analyses.

Final groups analyzed for the project contained smaller numbers of students than originally tested for a number of reasons. First, some schools failed to administer the pretest or posttest to participating classes or, at least, had

not returned completed test materials by the cut-off date for beginning data analysis (June 6, 1975). Second, since analyses were aimed at determining gains, any students who did not complete both the pretests and posttests were eliminated. Students had to complete at least the interest inventory, the problem-solving attitude scale, and knowledge test on both occasions to be included. Students who did not complete the career choice items were excluded only from the analysis of career choice data.

Data on the question generation technique were analyzed for all of the primary experimental and control students who had completed both the question generation and all of the other instruments. Due to the length of time required for scoring, the question generation instrument was scored only for a random sample of 100 students from each of the total experimental and control groups (excluding primary group students). These samples were selected from among those students who met the other requirements for inclusion in the final groups. Average scores of these subgroups of students on the interest inventory problem-solving attitude scale, and knowledge test were virtually identical to the total group averages on these tests.

--Data Collection

The test materials were developed and pilot tested as reported above and in the Interim Progress Report of July 1975. The principals in each experimental school and in each control school were telephoned to elicit their cooperation. Letters were written to the principals confirming the telephone call. In the case of the experimental schools, a letter was written to each teacher explaining the purpose of the study and the methods to be used in the collection of the data. A copy of the letter to the principal was enclosed with the test package to assure the teacher that proper procedures had been followed. In the case of the control schools, letters to the teachers

describing the purpose of the study and the methods of data collection were enclosed with the classroom packages of materials which were sent to the attention of the principal.

The test packages were distributed to the 25 experimental schools and the 22 control schools for the mid-October pretest, just prior to the on-campus workshop. The total population, experimental and control, surveyed was 1,799 students. All of the experimental schools included in the pretest cooperated and returned the completed test forms as requested, and 20 out of the 22 control schools returned data giving a total of 45 schools in the pretest population.

The posttest forms contained the same items on interest in science, but included an equivalent form of knowledge test and an equivalent form of the cognitive approach to problem solving. This was done to avoid the problems associated with the likelihood that the teachers discussed the pretest and used them as teaching instruments within the classroom. Posttesting was scheduled for April 1975. Completed forms were obtained from 37 out of 45 schools in the posttest population.

All data forms were logged in and each was scanned for missing information, improper markings on the optical scan forms and proper identification. Follow-up letters and telephone calls were directed to schools who had not responded by the deadline date with the posttest packages. The data forms were then coded to insure the anonymity of the respondents and the forms were pooled for analysis.

IN-SCHOOL STUDY

--The Schedule of Questions

The in-school study was designed to obtain from teachers their assessment of the impact of the workshops on students, their observation of how the

in-school phase of the workshops operated and finally, their judgment of the impact of these workshops on instruction. The overriding theme of this phase of the study was the extensive use of projects and problem-focused instruction in the schools. A schedule of questions was developed consistent with the objectives of the Green Bay Workshop Model as also outlined in the proposal. A pool of approximately 100 items was developed and reviewed by members of the Advisory Committee. Priority areas were identified and overlap was minimized.

An initial schedule of questions containing approximately 50 items was developed and pilot tested in two schools with teachers who had been active participants in the workshop but were not included in the case study population. As a result of this pilot testing, redundant items were eliminated and items which prompted excessive, unproductive discourse were revised or eliminated. A final schedule of questions, which consisted of 29 items, covered all of the objectives listed in the proposal and could be completed in a 45-minute block of time, consistent with the class schedules in most schools.

The final instrument, Document 1 (in the Appendix) included items concerned with:

A. Benefits to students in terms of interest and participation in science and science projects.

B. Project operation including impact on teachers, involvement of university personnel and limits which affected project operation.

C. Impact on instruction as evidenced by use of the problem/project approach in teaching, use of school and community resources, the development of new curricula and the ways in which the problem/project approach were evaluated and legitimatized.

The questions were for the most part open-ended but sufficiently structured so that the teacher's attention was focused on the central issue under consideration. This allowed teachers to discuss the details of the workshop operation while it also encouraged discussion of long-range changes in curricula and teaching methods.

--Population

As of the Fall of 1974, teachers from 64 schools had participated in one or more workshops on Water Quality, Air Quality or Solid Waste at the University of Wisconsin-Green Bay. This total includes teachers from both private and parochial schools. More than 10 percent of the school districts in the State of Wisconsin are included in this population.

In order to select the required sample of students, the state was divided into geographic areas which contained clusters of participant schools. The sample selected was representative of these areas: the greater Green Bay area, four schools; the Fox Valley area, three schools; the Milwaukee urban area, two schools; central Wisconsin, including rural and small towns, five schools; central Wisconsin, medium size cities, three schools. The sample included 15 public schools and two private parochial schools. These schools were selected to cover two or more years of workshop participation: three of the schools had participated for five years, two of the schools for four years, six of the schools for three years and six of the schools for two years. The final sample included 17 schools (two more than indicated in the proposal) which the Project Director and the Advisory Committee felt were representative of the scope of the workshops and the experience and interests of the schools. In all, 32 teachers were interviewed in these 17 schools.

--Interview Procedure

The Project Teacher served as the interviewer in all cases. This teacher

held a Bachelors Degree in Environmental Science with a Major in Biology and was certified as a teacher. After receiving intensive training in interviewing techniques, this teacher was accompanied on the first pilot interview by the Project Director. After extensive review of the pilot interview data and procedures, it was determined that the interview process was appropriate and would elicit the type of responses necessary in this phase of the study.

The schedule of questions was designed so that the interviewer read each question to the respondent teacher and then recorded the information directly on the interview form. (Electronic recording devices were not used on recommendation of the Advisory Committee.) Following each interview, the interviewer reviewed the completed questionnaire to insure that all questions were completed and that the answers were consistent with the intent of the question.

The principal of each of the 17 schools was contacted to gain approval for the interview. Actual appointments with the teachers were arranged via telephone with the teacher. Following each interview, a letter was sent to each principal expressing thanks for cooperation. The interviews took place over a six-week period and were concluded by March 30, 1975.

--Analysis

Analysis of case study data was carried on in two steps. First, the responses were tabulated and summarized for each item across all of the schools. Summary statements were prepared as "answers" to the questions posed in the original questionnaire. (Copies of these summary statements are included in the Appendix as Document 2.)

The questionnaire responses were again examined for trends and commonalities. From the second level of analysis, clusters of "case types" were identified where similar responses and expressed needs tended to merge and overlap. This analysis

was intended to identify special school conditions or needs which might be used to further refine the Green Bay Workshop Model and so better meet specialized needs of certain teacher groups.

The analysis of the questionnaire responses was carried on by the Project Teacher working directly with the Project Director and the Director of the university testing service. All results were reviewed periodically with the Advisory Committee. Summary statements were drawn up, critiqued and interpreted. The major points emerging from this interpretation are presented in the "Results" section of this report.

RESULTS

The results of assessment of the impact of educational innovation can appropriately be expressed in terms of impact on students, their knowledge, skills, attitudes and general educational development as well as in terms of improvement in the "conditions of learning" which can be inferred from changes in curriculum and teaching practices. In this study, changes in students participating in one solid waste workshop were assessed using the quasi-experimental pre-post-test design described above. In the case studies also described above, teachers were queried about corresponding changes they observed in their students over a much longer period of time as well as about changes in curriculum and methods. In the first section of the Results Chapter, evidence of impact on students will be presented from the experimental study followed by a presentation of information from the case studies. In the second section of this chapter, the impact on schools, teachers and curriculum will be presented.

IMPACT ON STUDENTS

--Experimental Study on Workshop Participants

Students who took part in the Fall 1974 workshop on solid waste were the target group for this investigation. The test packages were distributed to the 25 experimental schools and the 22 control schools for the mid-October pretest prior to the on-campus workshop. The test packages included an academic interest inventory, the problem-solving attitude scale, a test of knowledge about solid waste, a career choice index and a problem-solving question generation instrument. Twenty-four of the experimental schools and 17 of the control schools returned data forms from the April 1975 posttest. The total number of students and classes included in the final data analysis is shown in Table 1. Completed data forms were obtained and analyzed for 1,061 students including 45 students (90 percent) who took part in both workshop days on the campus.

It should be noted that while the question generation data were obtained and analyzed for all students who completed all instruments, random samples of 100 students from the experimental and control groups each were included in the statistical summary. This was made necessary due to the length of time required for scoring the question generation instrument.

TABLE 1

NUMBER OF STUDENTS INCLUDED IN FINAL ANALYSIS

	TOTAL		PRIMARY	
For Analysis of	Experimental	Control	Experimental	Control
Interest Inventory, Problem Solving Attitude, Knowledge	809 34 (C)	352 17 (C)	45 24 (C)	58 17 (C)
Career Choice	733	316	42	54
Question Generation	100	100	33	56

(C) = Number of Classes

Results are presented here in the order in which students took the tests. In general, each table shows pretest and posttest averages, change (posttest minus pretest), and a test of statistical significance on the change index for both primary and total groups. Major discussion of the findings is reserved until the next section of the report.

Table 2 presents the results for the total academic interest inventory, i.e. summing responses across the ten subject areas. Table 3 presents the results for just the science interest item. It should be recalled that in both of these sets of data low scores indicate a positive attitude or interest. A midpoint or neutral score on the total interest inventory would be 20, with a maximum possible range from 10 - 30. The midpoint score on the science item is 2.0 with

a possible range from 1.00 - 3.00. Tables 2 and 3 reveal no significant differences between experimental and control conditions either for primary or total groups.

T A B L E 2

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS ON TOTAL ACADEMIC INTEREST INVENTORY

Group	Pre	Post	Change	F
Primary				
Experimental	16.4	16.7	.38	1.22
Control	17.6	17.5	-.16	
Total				
Experimental	18.1	18.0	-.16	.21
Control	18.6	18.5	-.08	

T A B L E 3

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS ON SCIENCE INTEREST INDEX

Group	Pre	Post	Change	F
Primary				
Experimental	1.27	1.47	.20	1.79
Control	1.33	1.36	.03	
Total				
Experimental	1.64	1.63	-.01	.05
Control	1.58	1.56	-.02	

Table 4 presents results of the comparisons between experimental and control groups on the problem solving attitude scale. The possible range of scores on this scale is from 10 - 30, a high score representing a favorable attitude toward problem solving. There are clearly no significant differences in change in attitude toward problem solving between experimental and control groups.

TABLE 4

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS
ON PROBLEM SOLVING ATTITUDE SCALE

Group	Pre	Post	Change	F
Primary				
Experimental	23.3	22.9	-.33	.03
Control	23.9	23.6	-.26	
Total				
Experimental	22.3	22.6	.23	.00
Control	22.5	22.7	.22	

Table 5 presents results of the comparisons between groups on the test of knowledge about solid wate. The possible range of scores on this test is from 0 - 15. No significant differences between experimental and control groups occurred on the knowledge test.

TABLE 5

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS
ON TEST OF SOLID WASTE KNOWLEDGE

Group	Pre	Post	Change	F
Primary				
Experimental	10.0	10.5	.51	1.09
Control	10.6	10.6	.03	
Total				
Experimental	9.1	9.4	.35	.28
Control	9.1	9.4	.26	

Table 6 presents the analysis of the career choice data. These data were cast in the form of percentages of students giving each combination of response patterns from pre- to posttesting. As described earlier, student responses were classified as being either in an environmental (E) field or in some other (O) area.

For example, Table 6 shows that in the primary experimental group, 29 percent of the students choose at least one environmentally-related career on both the pretest and posttest, 12 percent choose at least one environmentally-related career on the pretest but did not do so on the posttest, i.e. went from an E to an O classification. What would be hoped for in terms of the workshop would be a significant increase in the O-E category. Unfortunately, while the difference between experimental and control groups in this category is in the desired direction, it is clearly nonsignificant. In addition, it can be noted that even more experimental students fell in the E-O category than in the O-E category.

TABLE 6

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS IN TERMS OF ALL THREE CAREER CHOICES

Group	E-E	E-O	O-E	O-O
Primary				
Experimental	29%	12%	10%	50%
Control	25	13	4	57
Total				
Experimental	18	11	7	69
Control	20	7	4	68

Table 7 presents results relating to problem-solving skills as indicated by the total number of questions listed. It is apparent that the posttest was harder than the pretest for all groups, presumably because of the posttest topic (Energy Uses in Your Community) was more difficult to deal with than was the pretest topic (Air Quality). Differences in change scores certainly do not favor the experimental groups; in fact, the differences tend to favor the control group.

TABLE 7

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS
IN TERMS OF TOTAL NUMBER OF QUESTIONS GENERATED

Group	Pre	Post	Change	t
Primary				
Experimental (N=33)	6.33	3.36	-2.97	-1.50
Control (N=56)	7.23	5.16	-2.07	
Total				
Experimental (N=100)	6.21	3.50	-2.71	-2.94
Control (N=100)	5.34	4.25	-1.09	

Table 8 presents the results for the question generation technique in terms of the percentages of questions asked in each of the six categories. (See page 9 for description of the categories.) By casting the data in the form of percentages, we eliminate the effect of differences in total number of questions asked. For both experimental and control conditions in the primary and total groups, the table shows the percentages of questions in each category and marginal totals for the pretest and posttest, and for the difference between pre- and posttest. The relevant comparisons in Table 8 are differences between the changes in percentage for a given cell in the right-hand portion of the table. Percentages were originally calculated to three places, then rounded to two places; thus sums of marginals will not always equal 100 percent.

Tests of statistical significance are not reported for these comparisons. There are obviously large numbers of comparisons that can be made between categories and marginal totals in Table 8. Most of the differences between experimental and control conditions are small. Statistical tests were performed on some of the largest differences and even these were found to be nonsignificant. It seems clear that the workshop did not have an effect on the types of questions asked by students.

TABLE 8

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS
IN TERMS OF PERCENTAGES OF QUESTIONS BY CATEGORIES[1]

		Pre				Post				Changes		
		A	B	Total		A	B	Total		A	B	Total
Primary Experimental	I	.01	.11	.12	I	.12	.18	.30	I	.11	.07	.18
	II	.46	.24	.69	II	.23	.30	.53	II	-.22	.06	-.16
	III	.02	.17	.19	III	.05	.12	.17	III	.03	-.06	-.02
	Total	.48	.52		Total	.40	.59		Total	-.07	.07	
Control	I	.00	.09	.09	I	.04	.09	.13	I	.04	.00	.04
	II	.58	.22	.80	II	.33	.30	.62	II	-.25	.08	-.17
	III	.02	.09	.11	III	.10	.15	.25	III	.08	.06	.14
	Total	.60	.40		Total	.47	.54		Total	-.13	.14	
Total Experimental	I	.00	.10	.10	I	.03	.16	.19	I	.03	.06	.09
	II	.56	.20	.76	II	.30	.27	.57	II	-.27	.07	-.19
	III	.01	.14	.15	III	.09	.14	.24	III	.08	.01	.09
	Total	.58	.43		Total	.42	.57		Total	-.15	.14	
Control	I	.01	.08	.09	I	.04	.12	.16	I	.03	.04	.07
	II	.53	.24	.77	II	.33	.29	.62	II	-.20	.05	-.14
	III	.03	.13	.16	III	.03	.19	.22	III	.00	.05	.06
	Total	.57	.45		Total	.40	.60		Total	-.17	.15	

[1] I = Social, Economic, Political

II = Scientific, Technological

III = Other

A = Extent, Measurement, etc.

B = Remedies, Action

(See Page 10 for a more detailed description of the categories.)

It may be worth noting that comparisons between data for the primary and total groups in Tables 2 to 8--comparisons which are not related to evaluating the impact of the workshop but are interesting nonetheless--almost without

exception are consistent with expectation. The primary students were selected or nominated by their teachers for workshop participation. And the instruments employed in the evaluation confirm the select nature of the group. In general, primary students scored higher or more favorably on all instruments.

The data as presented here do not indicate any significant, measured changes in academic interest in science, problem-solving attitudes, problem-solving skills, knowledge of the selected environmental problem, or changes in career choices in either the primary experimental or the diffusion students in the schools. It is clear that evidence has not been produced for the changes sought which have been described as "short term" or immediate changes related to participation in the two-day on-campus sessions and the approximately 20 days of data collection activity in the home community. Whatever the changes (if indeed they exist at all), they were not detected by the instruments used in this study.

--The Case Study

Long-range benefits were assessed in the case study section of the project through direct interview with participating teachers. Completed information forms were obtained from all of the selected teachers. Some of these teachers had participated for four or five years so they had an opportunity to observe growth in students and in their own teaching patterns over a period of years. The benefits to students derived from work in the various environmental workshops are presented here in order of frequency with which they were reported. Detailed response summaries for each item are included in the Appendix as Document 2. It should be noted that these are judgment statements collected from teachers and so are not directly comparable to the student data reported above.

Case study data were obtained from 32 teachers in 17 schools selected to be representative of the population of teachers and schools who had taken part in

the workshop activities since the inception of the workshops. The results of these interviews presented here will be limited to a discussion of long-term benefits to students in terms of nature of the benefits, groups who benefitted and interest in science and science projects. Discussion of the project operation and the impact on instruction will be presented in the next section.

--Benefits Identified by Teachers

The benefit to students most frequently cited by teachers was increased awareness of the scope of environmental problems. Monitoring techniques and data gathering and analysis procedures were also cited as a significant benefit. Increased knowledge of environmental problems was cited as was interaction with other groups (such as social studies teachers and classes) in the discussion of environmental problems. Opportunities for leadership within the workshop and in the monitoring phase were cited again and again as having significant value for students. One teacher reported that a student had become so motivated by work in the project that the student subsequently enrolled in a college to major in water quality studies. The overriding theme from this section of the case study was the benefit derived from meaningful involvement in data monitoring activity on a significant environmental problem which included the collection, the analysis and the interpretation of the resulting data. In all, more than 62 percent of the teachers interviewed reported increased awareness of the scope of environmental problems as the most important benefit.

The case study data also reveal that the teachers indicated an even greater awareness of the importance and scope of environmental problems among the diffusion students; that is, those students who took part in the data collection activity but did not have the opportunity to travel to the campus for the pre and post workshop days. This is in part explainable by the fact that the students selected for the on-campus participation were usually most able and had an already

heightened level of awareness of the problem. It is noteworthy, however, that the type of diffusion that was anticipated in the project design did indeed occur and that the classroom teacher cited the benefits which accrued to the classroom students.

There were two major miscellaneous benefits for students mentioned by teachers. Several teachers took special effort to mention leadership development and exposure to the university faculty and resource as benefits worth noting. The leadership opportunities for the students who attended the workshop on campus were expressed in terms of the opportunity for these students to relate their experience to the diffusion students in the high schools and then to exercise leadership in the direction of the monitoring and data collection activities of these diffusion students. The teachers also mentioned the importance of students seeing and being a part of credible, organized university research efforts. It appears that this involvement gave students an opportunity to see science in action, perhaps, for the first time.

--Groups of Students

The case study summaries indicate a variety of approaches for implementing project activities in the schools ranging from select small groups working after hours to total involvement of one or more classes. It was observed the teachers are able to incorporate project activities into their class structures and are able to manage these projects as legitimate learning experiences. It was noted that as the workshops evolved over the years, the nature of the proposed investigation (monitoring and data collection activities) changed also so as to be more usable with the entire class. Teachers reported that some students carried on the work for extra credit or as a substitute for major course requirements or as a science club activity. It is significant that in the solid waste workshop the range of student involvement ran from 25 to 300 students or more than ten

classes in a school. The typical school involved more than 95 students in this project. Earlier workshops produced less than half of this level of involvement.

--Interest in Science

Questions on increased interest in science brought a divided response from teachers. Some reported no change while others said that students were strongly motivated towards science by their involvement in the study of environmental problems. These teachers reported that such workshops in fact do motivate some students to continue work in the study of environmental science problems. They also indicated that some students are motivated to go on to college and continue work in these areas. However, the increase in interest in science seems to be more dependent on the student and on the local school situation than on participation in the workshop. The majority of teachers reported that changes in student interest in science could not be ascertained or that there was no evidence of change.

Apparently, the effect on students while dramatic in some cases, is not easily demonstrated in the majority of cases, if in fact it is present at all. Teachers did report continued interest and work on projects. In approximately one-half of the cases, some student activity was continuing either in terms of scaled-down data collection or in terms of a more intensive investigation of one aspect of the problem. As an example, one teacher reported that students were collecting sediments from snow samples as a follow-up to the air quality workshop. This represents an extension and a refinement of the techniques developed in the workshop.

In summary, the impact on students was not demonstrated in the experimental portion of this study, but teachers working with students did ascribe definite benefits to participation in the program. Sensitivity to environmental problems, understanding the complexity (multidiscipline facets) of the nature of the

problem, and development of investigative skills were the most frequently cited benefits. It was also clear that teachers were able to expand project operations to include entire classes thereby increasing the "diffusion" of the problem approach within the school.

IMPACT ON SCHOOLS

Studies of the diffusion on innovation/change (Rogers, 1962) indicate the personal commitment, established need of the proposed change and means of legitimatizing the change are important variables in the diffusion process. In this study, it was important to determine the extent to which other students (the diffusion students) were involved and it was also important to determine the ways in which problem-focused learning and science projects had been incorporated into the ongoing instructional program. This involved describing the process of operating the workshop activities in the school and describing the long-term impact on the instructional procedure.

--School Personnel

The impact of the workshops could be evidenced by the development of teams of teachers and students organized to examine a particular problem. The development of such multidiscipline teams was reported by 15 of the teachers interviewed. These teams included other science teachers and in 14 cases, the teams included social studies teachers. The students were discovering that the real world problems they were investigating not only needed analysis from the scientific point of view but also involved concerns appropriate to sociology, political science and economics. This fostered the development of instructional teams which included science and social studies teachers.

Actual guidance and supervision was reported to be a minor problem. Most of the data collection was done outside of actual classroom hours and so the

demand on teacher time was minimized. The projects were led by able students in school and these students exercised much of the leadership with other students.

The administrator's role in the project was reported as minimal. However, the principals did approve the project and gave permission for the teachers and students to travel to the campus for the workshop. This approval extended to the data collection. Only four teachers reported active interest on the part of their administrator.

--The University

The role of the university in the workshop operation was reported as significant by the majority of teachers. Five called the university's role absolutely essential and four others said "80 percent of the success is attributable to the university." The role included the initiation of the problem, the development of the complete operational format for the project, leadership opportunities for students, data collection and analysis procedures and interpretation procedures. There also appears to be a significant role "legitimatizing" project activities.

Contact with the university resulted in changes in the instructional program for all but seven teachers. The changes included expanding instructional programs to include environmental concerns and problems (ten cases), strengthening philosophy of science for projects (four cases) and implementing techniques and resources associated with the workshops (five cases).

Needs for more workshops, for problem-oriented teaching strategies and for appropriate materials were expressed by essentially all of the teachers. The university's role in this was not explored beyond recording the request to produce more workshops and to continue to develop new and different workshops.

--Limitations on Project Operation

The most serious limitation concerned the availability of students for

project work. The most able students are already fully committed to course work and extracurricular activities in music, theater, sports etc. and have difficulty finding time for yet another obligation. Furthermore in many schools, the students are bussed and must leave immediately after school. To work on a project after school is to force a student to miss the bus.

A second limitation concerns the workshop design which limited the number of students who could be involved in monitoring activities. The first workshops were designed for small groups of students. Since many teachers allowed students to work on the project during class time, the class was divided and many difficulties developed. Later workshops (solid waste) were designed to involve entire classes making use of small numbers of student leaders. This design worked well as evidenced by the significant increase in diffusion student participation as reported elsewhere. The earlier design created management problems and tended to greatly increase the work for the teacher.

A third limitation focused on materials and strategies needed for problem-focused learning and for the development of science projects. The teachers pointed out that in some areas there is a dearth of material and in others, a profusion of materials, many untried and untested. Consequently, the teacher is left to hunt for materials and then determine the legitimacy of these materials for classroom work. In the workshop, the university identified both materials and methods that worked. This procedure essentially legitimatized them for the teacher. However, after the workshop, the teachers were again on their own in terms of finding material. This impedes development of viable projects and the use of the problem approach in the classes.

--Projects and the Problem Approach in Instruction

The use of projects and the problem approach was reported by the majority of teachers. All but six teachers reported that they already use this method of

teaching. This high level of use probably provides at least some of the motivation for teachers to attend workshops such as these. Consequently, it is not too surprising that 16 teachers reported that they did not increase the use of projects or the problem approach after the workshop. In approximately one-third of the cases, an increase was noted both in terms of the use of workshop materials and practices and in terms of the acceptance of environmental problems as an appropriate focus and concern for high school level teaching.

The use of science projects was also of interest since there appears to be a declining interest in science fairs and even a declining interest in science. Also, any indication of an increase in project activity related to the Green Bay workshops, would be another indication of beneficial impact. The results indicated the following:

--Most projects are run as part of the class as opposed to out-of-class, after school activities, although, seven teachers reported such out-of-class activities.

--Most teachers report running six to 12 projects per year per class. Only four teachers reported no project activity.

--Most project success is reported for junior and senior levels of high school. It appears that students below this level do not have the expertise and maturity required to originate and follow through on such environmentally oriented projects.

--Most projects are prompted by teachers. In several instances, the idea for the project originated with the student or was brought up in class discussions or was prompted by contact with persons outside the school such as with university faculty and students. Still the teacher's influence predominates as "the source of project ideas."

--The design of projects frequently places the student in a position of organizing an interdisciplinary team to get information from the

social studies teachers, mechanical help from the shop, statistical help from the math teachers and policy papers from agencies such as the Department of Natural Resources or planning commissions.

--Students are free to collect data in the community during the school day. This was true in all cases. In 17 cases, class time was allowed and in others, free time (study hall) was available to the students.

--The importance of the workshop activity in changing instructional practices was reported as follows: 17 respondents reported changes in science project activity in terms of an increase in the number of projects (seven cases); improved techniques (four cases); environmental influences (four cases); and more local emphasis (two cases). Fourteen teachers indicated little or no change.

--Use of Resources

Evidence was obtained that the workshop activities did prompt teachers to look to their own regions, their own communities for problems and resources which could be used in instruction. Fifteen of the respondents indicated that problems and projects based in the local community were included in the school program.

The great majority of teachers (26), responded that the use of environmental problems in classes is beneficial to learning programs. Only one teacher indicated that such activity "hinders meeting objectives."

The extent of contact with other disciplines and the use of community resources and persons were established as important indicators of change in the schools. The Green Bay model strongly encourages the development of interdisciplinary projects and modes of instruction and it encourages the use of community resources in most every instructional effort. The respondents did report an increase in "contact with teachers in other disciplines" (ten cases), but the majority of the teachers expressed no change in their patterns of emphasizing "disciplinary science." Such transformation, undoubtedly, moves slowly.

Contact with community resources and teachers with special expertise was reported by 23 teachers, six of them indicating that such resource persons were frequently used. Examples included individuals from the computer and math analysis field, agency representatives from the Department of Natural Resources and planning agencies, personnel from the local sewerage district, community officials and university faculty.

It appears that working on environmental problems and projects does promote discussion with people in other fields but that this type of teaching is slow to develop and perhaps runs counter to the training of teachers and the tradition of schools. While the workshops encouraged this type of change, the teachers who adopt these strategies must be both ready and willing.

--Development of New Curricula

The development of new courses or revision of existing curricula was also established as an indicator of importance in the Green Bay model. In all, 18 teachers reported that the workshop project had led to new or revised courses; seven reported new courses emphasizing the new problem and project approach such as Environmental Monitoring and Resource Development; six teachers reported integrating the problem/project approach into existing curricula and three teachers have added the problem/project approach to advanced level courses. An additional two teachers reported such courses in the planning stage.

The establishment of such courses gives support to the belief that the Green Bay plan is having an impact, but it also raises questions concerning the need for continued development of materials and methods to sustain the operation of these courses.

--Evaluation and Legitimatization

Evaluation of student performance in science projects tends to be subjective in terms of effort and attitude on the part of the student.

In 11 cases, the teachers reported that students were required to prepare "a final paper" describing the project. The lack of standards and precedents for evaluation does cause some concern and raises questions about the legitimatization of project activity. In a lecture mode, the teacher and the student can demonstrate learning in terms of paper and pencil tests which have established credibility. In the case of research on a local environmental problem, e.g. the problem of solid waste and land fill, this external credibility is missing as is an easy means of reducing the activity to paper and pencil type of answers. The extent to which this is a problem for teachers has not been adequately researched. It appears to be a significant impediment in the more widespread adoption of the problem and project approach.

LEVEL II ANALYSIS, CASE STUDY TYPES

Results from the 32 interviews were examined for commonalities and for trends. When the responses were grouped according to extent of incorporation of problem-focused activities in the school, it was observed that the lowest level of activity was associated with the usual discipline-based courses and the maximum problem/project activity was found in interdisciplinary courses. This grouping resulted in the definition of five case types. No progression of the quality of activity is intended--only different types of activities.

1. Regular, single discipline science courses.
2. Advanced, single discipline science courses.
3. Introductory interdisciplinary science courses.
4. Advanced interdisciplinary science courses.
5. Interdisciplinary social studies courses.

This analysis is informative since it suggests that teachers in different courses require different types of problem activities in terms of scope, time, requirements, levels of sophistication and opportunities for legitimatization and integration. Each case type will be described in terms of salient characteristics.

--Case Type I: Regular, Single Discipline Science Courses

--Characteristics

These are traditional science courses offered in areas of biology, chemistry, physics and earth science. The courses emphasize the usual fundamental concepts and principles of the respective sciences and all are laboratory based. While 14 of the 20 teachers involved in such courses indicated that there was an increase in interest in environmental problems, it must also be noted that these same teachers indicated that the use of problem/projects increased student interest and provided motivation which was related to student learning. On the other hand, such problem approach and project activity was more difficult to handle and it did displace content which was part of the planned course. It should be pointed out that the population of students served in these courses differs both in its age makeup and ability makeup across the grades. Biology courses are taught primarily at the freshman and sophomore level and chemistry courses at the sophomore and junior level. Teachers indicated that students at the freshman/sophomore levels are less able to handle the responsibility for a project than are seniors. Teachers are also faced with upwards of 150 students per day in such courses so that management does become a problem. From this point of view, the early Green Bay workshops were least successful with students and teachers in this case type. The solid waste workshop, which had materials and activities designed for use with groups of class size, appeared to avert some of the difficulties identified by these teachers.

--Examples

"X" high school is a private school located in the Fox Valley and serves 600 students in grades 9-12. The teacher admitted that while being intrigued with the problem/project approach, experience and familiarity with it were lacking. The workshop provided the introduction and was very valuable. In general,

projects were not a part of the chemistry class. However, the teacher noted that there was an increasing level of interest on the part of students. The solid waste monitoring program was carried on in the general science class and this prompted him to include more problems and projects in this part of the curriculum.

"K" high school serves 600 students and is located in a small city in Eastern Wisconsin on the shores of Lake Michigan. This instructor reports completely modifying the approach of instruction to the problem/project approach as a result of the Green Bay workshops. He credited the workshops with giving him the impetus to adapt the existing curriculum so as to include appropriate projects of local concern. A major water quality monitoring program has been developed and is carried on by the students in the school on a cold water stream in the vacinity of the school.

"M" high school is located in the Milwaukee metropolitan region. This private school serves 1,000 students in grades 9-12. The teacher reported that the workshop had prompted the development of more problem and project activities within biology and chemistry classes. An environmental study module is being developed. The teacher commented that much of the solid waste workshop, however, was inappropriate to the direction his class was going and so such materials were not particularly beneficial at that point in time.

--Case Type II: Advanced Single Discipline Science Courses

--Characteristics

These courses offer high school students a second year of advanced intensive work in a discipline area such as biology or chemistry. Such courses are elective and serve mainly the gifted student who desires advanced level training in a laboratory course usually as preparation for scientific study at the college level. Unlike the introductory courses, these courses do not have a rigid syllabus dictated by a textbook. The instructor is more free to introduce problems and projects without fear of upsetting the long-established semester schedule. Instead, the classwork may focus on topics of local, regional, state or national interest with contemporary relevance as well as relevance to the basic discipline. Student projects played a significant role in these courses as a mechanism for independent studies and small group studies. Three of the four schools reporting such courses indicated that project activity constituted a major part of the course. Most of these projects could be classified as associated with environmental problems. It was significant that the UWGB workshops were reported to have been an important resource and impetus for the development and expansion of these courses. Follow-up activities associated with the workshops were much in evidence.

--Examples

"W" high school serves 177 students, grades 9-12 and is located in a rural area of Northeastern Wisconsin with abundant natural resources. The area is relatively free of water or air pollution. The students had little idea of what water quality problems really were until they attended the water quality workshop. This experience raised significant questions for them in terms of the chemical and biological factors associated with the problem and mechanisms for preserving the water quality in their local "wild river."

"F" high school is in a rural farm area adjacent to the Fox River Valley. The school serves 550 students in grades 9-12, essentially all of them drawn from the surrounding farm area and bussed to the school. Advanced science courses in biology and chemistry rely heavily on projects, many of them related to the projects that were introduced in the UWGB workshops.

"G" high school serves 1,500 students in grades 10-12 and is located in the greater Green Bay metropolitan area. An advanced biology course continues to flourish and attract the most able of students. The format of the course includes extensive field work, with a substantial number of projects run each semester. The project activity has increased since the introduction of the Green Bay workshops.

--Case Type III: Introductory Interdisciplinary Science Courses

--Characteristics

Courses in this case type were designed as alternatives to the usual discipline-based courses of biology, chemistry and physics. Courses are designed for students who elect not to pursue the basic science courses but still need science credit for graduation. Courses in agriscience, forestry, conservation and environmental studies have developed. Unlike the catch-all course, General Science, these courses have a particular focus or mission which relates to the problem area which is used as the course organizer.

The courses are popular with many students, expecially those who are not college bound. The courses usually do not have a rigidly established course outline but rather follow a general theme making maximum use of local environmental problems. Generally, no text is used and revisions in course structure and outline occur yearly. The instructor frequently develops materials specific to the problem under consideration and appropriate to the students enrolled in the class.

--Examples

"D" high school serves 1,500 students in grades 9-12 and is located in the Wisconsin River Valley, an area heavily dependent on manufacturers of paper, paper products and wood products. The school offers a course in conservation which stresses forestry. The project and problem approach is used extensively, but the type of investigation which is carried on must be designed to fit the abilities and experience levels of the students in the course.

"S" high school serves 550 students in a rural area in Northeastern Wisconsin. A course in Natural Resources focuses on problems of local environment, particularly, those related to agribusiness. The enrollment in the course has doubled in recent years and the students describe the course as highly relevant and popular.

The teacher is an enthusiastic supporter of the problem/project approach. The Green Bay workshop program was instrumental in the development of the course and the teacher assumes the responsibility for designing the project/problem sequences which are used.

"N" high school serves 1,300 students in grades 11 and 12. It is located in the Fox River Valley in an area heavily dependent on the Fox River for industry. The school offers a course called "Environmental Science" as an alternative to other lab sciences courses. The students electing this alternative are engaged in some low-level monitoring activities in the community in conjunction with projects developed in the course. The course does not have a textbook but does focus on local problems. The Green Bay workshop materials have been successfully implemented. The teacher has indicated a desire for additional materials associated with environmental problems in the local community.

--Case Type IV: Advanced Interdisciplinary Science Courses

--Characteristics

The ecology movement of recent years has prompted the development of a number of courses focusing on environmental problems. Five schools surveyed had courses of this nature. The courses tend to be rigorous and are designed for highly motivated, talented students who have completed the courses in the basic science disciplines and have a strong interest in environmental science. The schools in which these courses were developed tend to be large and progressive. The instructors tended to have training in interdisciplinary problem-solving areas and the courses stressed problem/project work. Local environmental problems received considerable attention. The UWGB workshops provided materials which were extensively used and expanded upon in these courses.

--Examples

"W" high school serves 1,800 students, grades 9-12 and is located in a medium-sized city which is heavily dependent on the paper industry and related wood products manufacturers. A course has been developed entitled "Man in His Environment" which focuses on local problems. Students are required to do projects. The original design of the course called for a team of science and social studies teachers, but financial constraints have reduced the faculty support to one member of the science department.

"A" high school serves 1,800 students in grades 10-12 and is located in the Wisconsin Fox River Valley. A course entitled "Environmental Monitoring" has been developed and is staffed by a member of the science faculty and a member of the English faculty. One of the teachers has completed Masters work on the problem/project approach in cooperation with a National Science Foundation project and has been able to implement this approach effectively through this course. Science content is stressed as is communication in terms of written

technical reports. The course is operated on a pass-fail basis and the students are free to work on their projects at times to fit their own schedules but must report their progress once a week.

"W" high school serves 1,200 students, grades 10-12 and is located in the Milwaukee metropolitan area. This school has developed two advanced interdisciplinary courses focusing on the environment. "Environmental Education" is a science elective for students who wish to pursue this type of science study. The course includes much project work which accommodated well the Green Bay Workshop Model. The second course, "Environmental Seminar" is designed for honor students who wish to research a specific environmental problem. Students prepare detailed reports of their investigation and their recommendation and present these reports to the classes of Environmental Education. Grading in the Environmental Seminar program is limited to A, B, F. Through these two classes, approximately 100 students per year are involved in environmental activities including those associated with the Green Bay workshops.

--Case Type V: Problem-Focused Social Studies

--Characteristics

The solid waste Green Bay workshop was designed for science and social studies teachers functioning as a team. It is not surprising, therefore, that the social studies teachers who were interviewed had an interest in environmental problems since they had "self selected" for inclusion in the group. Nevertheless, the problems and potentials encountered here are important as a type.

The junior and senior level social studies courses in this case type focus on problems of contemporary society. Though the background of essentially all of the social studies teachers was strong in one or more aspects of social studies, it was usually very minor in the sciences. The same teachers found the environmental problem approach quite appropriate to the objectives of their problem-focused social studies course but had difficulty bridging the gap between the political-social-economic issues and the science/technological information which was stressed in the workshops. The proposed field activities were not well implemented in these courses.

--Examples

"D" high school has 1,500 students in grades 9-12 and is located in the heart of the lumber/paper producing region of Wisconsin. The solid waste monitoring activities were followed but there was no follow up. The teacher was interested in the political aspects of solid waste management and saw this as an important and useful area for his course, but not enough such information was included in the workshop and the teachers did not have access to appropriate materials. Related issues of concern were local land use, zoning and agency activities such as the Environmental Protection Agency and the Wisconsin Department of Natural Resources. It appeared that a need had been identified but not met.

"P" high school serves 900 students in grades 9-12 in the Greater Green Bay area. The teacher expressed interest in problems of economics and ecology but admitted the need for additional materials and methods. The workshop was seen as useful in providing "ideas" for a new course being developed and entitled, "Futurism." This course will deal with long-range planning, alternatives and environmental problems. Aside from this new course, the science aspects of environmental problems received little attention in the social studies courses.

Observations

This analysis reveals that clusters of teachers need special methods and materials for their respective course types. What will serve one group of teachers and students in advanced interdisciplinary courses most likely will not work well in the basic discipline courses and vice versa. This suggests that special workshops be set up for specific teacher groups. This analysis also suggests that some schools have progressed quite far in their development of problem/project types of instruction, others have not.

IMPACT ON THE UNIVERSITY: COSTS AND BENEFITS

The Green Bay workshop plan as outlined briefly above is a low cost means of extending university resources to schools of a region or state with a minimum of disruption to the university and to the school. The model, which is outlined in detail in the IDEA Handbook (in press), requires the services of a workshop coordinator, "contributed" services of faculty on a planning committee and the time for faculty lectures during the two on-campus days. In addition, it requires a modest budget for supplies expense and travel. The direct costs to the University of Wisconsin-Green Bay are shown below.

Direct Costs for Environmental Workshops

1. Coordinating Teacher - 1/2 time x $10,000	$5,000
2. Supplies expense and travel - $1,000	1,000
	$6,000

These direct costs can appropriately be spread over at least two workshops per year, one in the Fall Semester and one in the Spring Semester.

Indirect costs cannot easily be documented or estimated but the types of effort can be listed. These included administrative services in the supervision of the workshop effort which can be part of the regular load. This also includes coordination with the appropriate Dean; faculty time on the planning committee which is a usual part of faculty governance and usually amounts to four meetings prior to each workshop or about eight meetings per year; faculty time for teaching in the workshop and to oversee the data reduction, analysis and interpretation prior to the second day on campus. The indirect costs are by no means trivial but are assignable to the public service function which is a part of the mission of this campus and of most other campuses. Put another way, the faculty who take part in the planning and implementation of these workshops receive no extra compensation for their efforts. It is an accepted, contributed part of load.

A second cost factor must be considered although it is not a university budget item. The costs to the schools for teacher participation can be significant. Aside from the transportation which some schools pay, all schools must hire replacement or substitute teachers for the two days the regular teachers are absent from their schools. The costs range from $25 to $45 per day depending on the district policies. In schools where the budget is very tight, this can be a significant factor; probably more from the point of view of precident established within the district than from the point of view of the dollars involved. Nevertheless, as costs and benefits are assessed, this significant factor must be considered. Also, this may well be the largest barrier to the expansion of the Green Bay model for workshops in the eyes of school personnel.

Benefits derived from the Green Bay Workshop Model have been discussed at length above for students and for teachers. Suffice it to say here in summary form that the benefits include the introduction of problem-focused methods and materials, on-going revision of curriculum, a form of in-service education for teachers via the workshop sessions and the contact with personnel in scientific research activities and a means of providing special programs for special students.

Benefits to the university include an opportunity to serve schools, teachers and students in the region and the state by introducing them to research methods and materials and to infuse into the schools a way of approaching learning (and environmental problems) which is consistent with the academic plan of the university. A side benefit to the campus, mentioned by the teachers as a benefit also to the students, was providing the students the opportunity to explore a campus as an institution of higher education. For many students, this was the first time they had ever visited a college or a university. The benefit to the university is obvious--it is fulfilling part of its education mission,

albeit in a small way, by providing students some motivation and opportunity to explore education beyond the high school level.

Actual calculations of cost benefit ratios can be misleading given the wealth of indirect costs outlined above. In terms of the direct cost which averages approximately $3,000 per workshop, the cost per participating district, teacher or student is indeed modest. In fact, given the data reported above where the solid waste workshop actually involved more than 1,600 students within the local schools, the cost per student is less than 50 cents.

It is both rewarding and somewhat startling that for such a modest investment students and teachers in a region can share in the research activities and resources of a university. However, as pointed out above, the actual indirect costs to the schools and the university are not included in this observation. Nor is there included any estimate of the worth of the symbiotic relationship that develops between the schools and the university in terms of long-term "payoff" to both institutions and their students. This could be the most important benefit.

OBSERVATIONS AND SUMMARY

Throughout this report various observations and summary statements have been made. The purpose of the present chapter is to summarize these so as to point up the strengths and weaknesses, the problems and the potentials of the Green Bay Workshop Plan as assessed in this project.

Benefits to students which were not demonstrated in the experimental study were described by teachers in terms of opening up new problems and areas of concern, introducing students to new methods of data collection and analysis and opportunities for leadership. The changes we sought after one workshop were not observed. Perhaps, the teachers responded to changes which take place in the schools over a longer period of time.

It is intriguing that the ideational fluency as indicated by the problem-solving study was so low. The student's skill in using the language of science to describe a problem seems to be distressingly lacking. This finding is consistent with and adds to the recent national concern over general communication abilities and it deserves more attention at the research level and within the classroom.

The impact of the workshop is considerable in terms of the number of students involved and in terms of the number of teachers and schools involved over a period of years. The positive assessment of the workshop is evidenced by the teachers' positive response and by the number of teachers who continue to come to the workshops year after year or who encourage their colleagues to attend.

The role of the workshops in revising science curricula should not be underestimated. Teachers who attended are looking for ideas. They are interested in changes or most likely they would not be present. This is suggested by the number who report adopting part or all of the workshop methods and materials in their class or who have initiated new interdisciplinary courses for high school students.

The spread of the problem/project approach to instruction in the high school appears to be related to the workshops. At least the teachers indicate this in their responses and report finding usable ideas and project activities which they integrate into their curriculum.

The university serves many roles--it is a catalyst in getting the workshop project off the ground; it is an organizer for the "investigation;" and it is a legitimatizer, a state agency that says these investigations are not only "ok", but they are a legitimate and in fact an appropriate mode of learning.

Benefits and cost discussions reveal that many indirect benefits and costs can only be suggested at this time. The direct cost per high school student served is less than 50 cents. The benefit to the schools, to the students, to the teachers and to the university can and in fact appear to be substantial.

Recommendations

Studies such as this usually conclude with a statement that more research is needed. A slight variation will be introduced here. The teachers report the following limiting factors and needs:

1. Funds for released time are scarce and this can and does act as an inhibitor for expanding workshop participation.
2. Funds for materials needed for projects and problem-oriented teaching are scarce.
3. More workshops are needed to continue the expansion of these problem-oriented strategies into the high school curriculum.
4. More problem-focused materials are needed at the high school level which are compatible with existing curriculum and teaching objectives.

The recommendation which emerges from this study is that the Green Bay plan be replicated in several other areas with modest sums of money (perhaps on a matching basis) made available to the schools who take part. The impact and operation of this type of diffusion effort should be carefully monitored.

--Conclusion

The objective of this study was to assess the impact of the Green Bay plan in terms of benefits to students and benefits to schools and changes in teaching practices. The report seems clear. A few days participation in research activities does not produce measurable changes in students. On the other hand, the teachers show both by their response and by their actions that the plan is operating well and is having the desired impact on schools, their curriculum, the teaching methods and most importantly on students. Many problems and shortcomings have been identified in the workshop plan, but the overall assessment indicates that the Green Bay model does work and does produce changes that are judged worthwhile.

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APPENDIX

Date: _____

Name of School _____ Name of Teacher _____

I. UW PROJECT _____ Teaching Area _____

AND DATE _____

1. What were the major benefits to you and your school from your participation in the _____ workshop project?

2. In your estimation, how many students in your high school had something to do with the workshop project each year, in addition to those going to the campus?

3. To what extent did students who attended the campus workshop benefit from the project?

   a. Greatly
   b. To some extent
   c. Very little

   What were the benefits?

4. How were students not attending the workshop worked into the project?

   To what extent did these students benefit from their participation?

   a. Greatly
   b. To some extent
   c. Very little

   What were the benefits to these students?

5. To what extent have students continued to work on the _____ project after the workshop ended?

   a. No activity (
   b. Continued project work (Give examples
   c. Expanded projects (

6. Has there been any evidence that these science projects stimulated increased interest in science?

   a. Yes
   b. No
   c. Unknown

7. What other teachers were involved in the _____ projects?

   a. None
   b. Other science
   c. Social Studies
   d. Other

8. How much guidance and supervision was required on your part?

   a. A great deal
   b. A very modest amount of guidance and supervision
   c. Essentially none

9. How significant was the University's role in ensuring the success of the project? (Probe)

10. To what extent was your building principal aware of participation in the UWGB project by you and your students?

11a. What was the weakest part of the UWGB workshop?

11b. What is the most difficult part of running the project in your school?

II. SCIENCE PROJECTS AND THE PROBLEM APPROACH IN INSTRUCTION

Let's consider the problem-approach to teaching which usually means using a problem situation (local conflict which is known to students) as a vehicle for your teaching. Let's also consider science projects which may be student-designed and run and usually involve small groups of students studying a problem, collecting and analyzing the data and reaching some conclusion.

12. Since the workshop, have you increased your use of environmental problems or projects in your classroom teaching?

    a. Seldomly use the problem approach
    b. No increase
    c. Increased use (Probe)

13. If you have increased your use of problems in teaching, are these of local origin and importance, or are they primarily from text materials?

14. Does the study of environmental problems help or hinder your students in meeting your objectives?

    a. Helps
    b. Hinders
    c. Makes no difference

15. Has the use of environmental problems led to increased contact with other teachers and disciplines (such as social studies, art, shop)? How?

    a. Yes, increased contact
    b. No change
    c. Other

16. To what extent have resource people outside the school been involved in these projects and classes?

    a. Not at all
    b. Occasionally
    c. Frequently

17. Has project activity led to any new courses or revised curricula? Describe.

18. Are science projects primarily run as a part of classes or as separate out-of-class activities?

    a. Run as a part of class (Name classes)
    b. Run separately
    c. Run both ways
    d. Essentially no projects (Go to Question 22)

19. Describe your science projects.

    a. On the average, how many science projects are run in your school each year?
    b. At what grade level do most projects occur?
    c. What kind of projects have been developed?
    d. What prompted their development?

20. Consider the science projects run in your school.

    A. To what extent do students initiate and design their own projects?

        a. Not at all
        b. Usually
        c. Frequently

    B. How do students start a project?

    C. Who helps them design the project?

    D. Whom do they contact?

    E. Do you permit the students to go off the school grounds to collect data?

21. How have your science projects changed since your participation in the UW workshop?

22. To what extent does your school administration support project activity?

    a. To a great extent
    b. Somewhat
    c. Lack of support

23. How do you evaluate student's participation in science projects?

24. Time

    A. To what extent is teacher time a limiting factor in the development of new science projects?

        a. A great limiting factor
        b. A moderate limiting factor
        c. Not a significant limiting factor

    B. To what extent is student time a limiting factor in the development of new science projects?

        a. A great limiting factor
        b. A moderate limiting factor
        c. Not a significant limiting factor

25. In what ways does the study of environmental problems affect student interest in science?

    a. Increase
    b. Decrease
    c. No difference

26. In what ways does the study of environmental problems affect student learning in science?

    a. Increase
    b. Decrease
    c. No difference

27. Have you found adequate teaching materials and activities dealing with environmental problems and science projects?

    a. Yes
    b. No

28. In what ways has contact with the University been useful in your efforts to change your instructional program?

29. Do you feel a need for--

    a. More workshops for teachers and students
    b. Materials and guides for science projects
    c. Problem-oriented instructional materials for use in classes

III. BACKGROUND INFORMATION

Size of school

Grades in building

Changes or trends in enrollment in science classes

SUMMARY OF RESPONSES TO CASE STUDY QUESTIONNAIRE

1. What were the major benefits to you and your school from your participation in the _____workshop project?

Most of the respondents (15 out of 32) cited an increase in awareness of environmental problems and their importance as a major benefit. The teachers reported that the workshop aided them in becoming sensitive to the scope of the environmental problem and its relationship to other facets of society. Relevance to the school curriculum was noted in terms of problems with narrowness of discipline-centered definitions of these problems.

The teachers also reported (15 out of 32) a significant increase in background knowledge of environmental problems, both for students and for themselves. Background knowledge was described as specific information relevant to the environmental problem.

Next in importance was the development of techniques for working in environmental problem areas, which includes both methods and materials for classroom activities, data collection, methods of analyses of samples and sources of information. Eight teachers reported this as a major benefit and an additional five teachers described this simply as an increase in ideas which were usable to the teacher.

A variety of other benefits were cited, including increased contact with other schools, which gave students from small schools an opportunity to interact with their counterparts from the larger urban schools, to discuss problems unique to each, and to explore environmental problems which were relatively unknown or unimportant in the locale of the school, such as water quality in an area many miles distant from any open water. The teachers also reported that the workshop provided a leadership experience for students, since the workshop allowed the student to take the initiative for data collection back in the local school. Similarly, the teachers reported that participation in the workshop was a motivating factor; a type of reward for the students selected and a type of recognition because of the special activities back in the school. Teachers also cited the benefits which accrue to students from firsthand contact with the college environment. In at least one school, family benefits were cited as important. The students carried the message of environmental problem monitoring home to the parents, who shared in the eye-opening experience and followed the progress of the study. Some of these parents contacted the teachers and the building administrator to voice their enthusiasm and support for this kind of activity.

Other teachers cited opportunities for full class involvement in the monitoring project and in exploring environmental problems of local significance. One school noted that the workshop program led to the establishment of an environmentally-focused instructional program within the school. Only two teachers reported that the workshop produced very little benefit. Further study of these responses showed that in these two cases there was essentially no follow-up or in-school activities by the classroom teacher.

2. In your estimation, how many students in your high school had something to do with the workshop project each year, in addition to those going to the campus?

Examination of the data in Table 1 reveals that in three out of eleven schools multiple classes of students were involved. In the other cases, small groups of students carried on the monitoring activities. In some cases, this was a "select class." In other cases, it was a special group; a subgroup of a regular class. In three cases, the schools reported that they attended the air quality workshop, but did not implement the data collection phase at all within the school. The water quality workshops resulted in four schools where multiple class student participation was noted. Only two schools reported that they did not implement the in-school phase.

The solid waste workshop was implemented in all seventeen schools and involved 24 to 300 students per school. It was noted that the school in which twenty-four students were involved has a total enrollment of 177.

Several observations can be made from these data. As the University has gained more experience in operating workshops, the level of student activity suggested for the high school has increased. Also, the activities have been structured so that they can be carried on by an entire class of students, as opposed to individual or small group monitoring activities. It is possible that there are two different factors operating; the first, that solid waste activities lend themselves more appropriately to this type of workshop and monitoring activity; and the second, that the structure of the University program changed so that more in-school participation was made possible.

Question 2.

Table 1

NUMBER OF STUDENTS PARTICIPATING IN ENVIRONMENTAL PROBLEM STUDIES
1971-74

School	Air[1]	Water[2]	Solid Waste[3]	School Size
1.	15	-	110	1300
2.	100	100	100	600
3.	-	0	130	1800
4.	15	15	24	177
5.	-	-	35	600
6.	0	0	50	625
7.	4	-	40	1100
8.	13	-	85	550
9.	-	50	25	170
10.	-	150	80	1300
11.	0	8	180	875
12.	0	-	152	1550
13.	20	20	75	1543
14.	-	17	85	430
15.	100	-	300	1800
16.	75-100	75-100	75-100	1200
17.	-	-	50	1000

Key

- denotes did not attend
0 denotes attended but did not implement at all

1. Spring 1973
2. Spring 1972 and Spring 1973
3. Spring and Fall 1974

3. To what extent did students who attended the campus workshop benefit from the project?

   a. Greatly
   b. To some extent
   c. Very little

   What were the benefits?

For those people attending the air quality workshop, five out of thirteen reported great benefits. An additional five reported that the benefits varied between great and to some extent. Three reported benefits of some extent, and no person reported benefits diminished below this level. Again, the benefit most frequently cited was increased awareness of the scope of the problem of air pollution. Cited second in importance was exposure to the University environment, including procedures and personnel. Monitoring techniques were again cited as a significant benefit in the air quality workshop. Increased knowledge of the parameters of air pollution was cited, as was exposure to other schools, involvement in environmental problem discussions for students, general motivation and exposure to the broad field of environmental problems. Opportunities for leadership within the workshop in the school monitoring phase were again cited.

Among those schools attending the water quality workshops, three out of eleven reported great benefits to the students who attended the workshops. Five reported benefits varying from great to some extent, and three reported some benefits to the students. No schools reported benefits diminished below this level.

These teachers reported that increased awareness of the scope of the water problem and experience in field monitoring techniques were among the most important benefits. Increased knowledge in the area of water pollution was cited, as was leadership opportunities, exposure to the University and its environment and involvement in a hands-on workshop activity. One teacher reported that a student has subsequently gone on to major in this area at the college level, and is pursuing a career in water quality work. An overriding theme is the opportunity for students to be involved in monitoring activities in the collection, analysis and interpretation of data.

Among the twenty-six teachers participating in the solid waste workshop, six reported that the students benefited greatly, while nine reported that the benefit to students varied from greatly, to some extent. An additional nine teachers reported that students benefited, at least to some extent. Two teachers reported that there was very little benefit to students. Further probing of these responses revealed that the students selected for participation were disinterested in environmental topics and essentially refused to participate beyond the day's excursion to the campus. The teachers were unanimous in their observation that the benefit to the student was, to a large extent, determined by the type of student selected. The opportunities for great benefits were present.

3. (Continued)

In commenting on specific benefits, the majority of the teachers, sixteen out of twenty-six, reported increased awareness of the scope of the problem of solid waste. Monitoring techniques were reported as significant benefits by seven out of the twenty-six teachers, as were increased competence and opportunities in data collection techniques in the field, in a broad area related to environmental quality, as opposed to the general restricted activities of the classroom laboratory. Again, leadership opportunities, increased knowledge, contact with other schools and contact with the University were all cited by several teachers as significant benefits. One teacher noted that the participation in the workshop was a significant motivating factor for students. Several teachers reported that the workshop provided a mechanism by which students could be directly involved in a relevant and local science-based activity.

4. How were students not attending the workshop worked into the project?

   To what extent did these students benefit from their participation?

   a. Greatly
   b. To some extent
   c. Very little

   What were the benefits to these students?

The responses from teachers were approximately equally divided between having the activity as a required part of a class (12 teachers) and selecting volunteers (12 teachers), however, an additional five teachers indicated that student volunteers were selected and granted extra credit for their participation. Two teachers indicated no follow-up; two teachers indicated that the participation was used as a substitute for a major requirement, such as an examination; and one teacher reported that the participation was used to acquire extra credit involving points. In one school, a science club adopted the project as a club activity.

The extent of benefits were described as follows:

1. For air quality, three teachers reported great benefits; two teachers reported benefits great, or to some extent; five teachers reported benefits to some extent; and two teachers reported very little benefit.

2. For the water quality workshop, two teachers reported great benefits; three teachers reported great, or to some extent, benefits; four teachers reported benefits to some extent; and two teachers reported benefits restricted to very little.

3. The solid waste workshop resulted in five teachers indicating great benefits; three teachers indicating benefits ranging from great, to some extent; fifteen teachers showing benefits at some extent; and four teachers reported very little benefit.

Air Quality Workshop

An increased awareness of the problem was cited in seven cases as the major benefit for students not attending the workshop. Awareness of the problem, again, referring to the eye-opening experience of all the converging ramifications of the air quality problem. In five responses, increased background knowledge was mentioned as a major benefit for students in the schools who participated in the air quality project.

In three cases, air quality monitoring techniques were mentioned as a benefit.

In three cases, no benefits were mentioned, since no follow-up occurred.

4. (Continued)

Water Quality Workshop

Again, awareness was cited as the primary benefit for students in the schools, with eight responses.

Four responses identified improved monitoring techniques as a major benefit, and in three cases, background knowledge of the water quality problem was mentioned as a benefit.

Also mentioned were such things as experience gained in doing environmental field work and motivation to do something in the field.

In two cases, no follow-up and no benefits were reported.

Solid Waste Workshop

Twenty responses indicated increased awareness, since many students in the high schools are not cognizant of the scope of environmental problems.

Increased knowledge of a factual nature was offered seven times as a major benefit for students in the schools.

The developing and implementing of environmental monitoring techniques was offered four times as a benefit for students in the schools.

Motivation and experience in environmental problem solving were mentioned three times as a benefit.

There were two cases of no follow-up or continued activity.

5. To what extent have students continued to work on the _____ project after the workshop ended?

a.	No activity	(
b.	Continued project work	(Give examples
c.	Expanded projects	(

Air Quality Workshop

Six of the thirteen respondents identified no continued project activity related to the air quality workshop. Two mentioned some activity, but at a very low level. Three indicated continued project work, and two mentioned projects expanding to new areas. One teacher mentioned that he planned to use the air quality techniques in his course. Investigations into new areas mentioned by individual teachers included snow sediment studies and extensions of the University project design.

Water Quality Workshop

Four of eleven respondents indicated no further activity in relation to the water quality workshop; three indicated that the project work was continuing; and four teachers expanded the water quality workshop to new projects.

In one case, this water quality workshop became a part of the regular curriculum. In four cases, the water quality monitoring techniques were applied in new areas.

Solid Waste Workshop

Twelve of twenty-four respondents indicated no further activity after the workshop ended; six continued project work after the workshop ended; and six expanded the project to new areas. There were three cases where projects regarding solid waste were started at the school. These were recycling programs originated by students and run by students. The solid waste monitoring procedure, as developed by UWGB, was to be implemented again by teachers in future classes in four cases.

Continuing discussions about the solid waste problem was mentioned one time as a continuation activity.

6. Has there been any evidence that these science projects stimulated increased interest in science?

   a. Yes
   b. No
   c. Unknown

Response to a. - Yes was given ten times.

Response to b. - No was given eight times.

Response to c. - Unknown was given fourteen times.

Identifying increased interest is a difficult thing to do. A rather subjective, intuitive evaluation of increased interest had to have been made by the teachers to give a yes or a no response. Many of the no responses refer to the lack of evidence rather than to their feeling or intuition.

7. What other teachers were involved in the _____ projects?

a. None
b. Other Science
c. Social Studies
d. Other

In seven cases, no other teachers were involved in the projects. In fifteen cases, other science teachers were mentioned. In fourteen cases, social studies teachers were mentioned. This large number of science and social studies is attributable mainly to the workshop design which requested schools to send "teams" of science and social studies teachers. In this manner, other teachers were involved in the projects. There were two cases where teachers other than social studies or science were involved. These were where a math teacher was involved in some statistical evaluation, and a shop teacher was involved in some equipment development.

8. How much guidance and supervision was required on your part?

a. A great deal
b. A very modest amount of guidance and supervision
c. Essentially none

A great deal of guidance and supervision was required in four of the responses. A very modest amount of guidance and supervision was given as a response twenty-two times. Six teachers reported that essentially no guidance or supervision was required.

9. How significant was the University's role in ensuring the success of the project? (Probe)

The University's role was considered significant by most of the respondents. The description "absolutely essential" was given five times. Four teachers reported that in their opinion "eighty percent of the success was attributable to the involvement of the University." "Very important" was given as a response, ten times.

Some of the comments offered by the teachers as to how the University's role was significant were as follows:

> Five teachers identified the University's role as a significant motivating force that was felt by the teachers and students. Twice the speakers and demonstrations were mentioned as important, and twice the "completeness" or "quality" of the project was mentioned as important. The professional air of the program and the leadership influence on students were also mentioned as significant in the University's ensuring the success of the project.
>
> There were six cases of teachers stating the University's role was little, outside of initiating the project, and two mentioned only to some extent was the University's role significant. There was one case of no follow-up or continuation of the project and, therefore, no way of telling.

10. To what extent was your building principal aware of participation in the UWGB project by you and your students?

Little interest at all was shown by principals in 20 of the 33 responses. There were four responses of slight or some.

Very active interest on the part of the principal was given as a response four times. In one case, parents called the principal complimenting him and the teachers for participation in the solid waste workshop. They reported that the in-home phase was an interesting experience for them. The principal "got involved" following these phone calls.

The remaining responses identified a small interest shown by the principal.

11a. What was the weakest part of the UWGB workshop?

Air Quality Workshop

Five responses in this category showed that the air quality data collection was not carried on in the high school.

A poor wrap-up was identified four times. Also mentioned as a weakness was not having enough activity for the students to do.

There were three times, however, when the air quality workshop was said to have no real weaknesses..

Water Quality Workshop

The water quality workshop was said to be above the capability or background of the students by five of the teachers.

More time for sampling and a better wrap-up session were suggested two times.

More activities for students to do at the workshop was mentioned once.

One teacher reported no real weakness in the workshop.

Solid Waste Workshop

The statement "the lectures lost the students" was given as a response the most (13) number of times. This referred to the amount of lecturing done, as well as the level at which the lecturing was presented. Even considering that the better high school students were chosen in most cases, they are, nonetheless, high school students.

The complexity of directions given were mentioned as a major weakness four times. This was corrected in the second solid waste workshop.

The first solid waste workshop was troubled with problems of getting materials back to the high schools. This, plus a poor wrap-up was mentioned as a weak part of the workshop by five teachers.

A lack of student activity in the workshop was given as a weak point.

Teachers suggested more time for the computer game, and more time for data collecting.

Three teachers indicated no real weakness to the solid waste workshop.

11b. What is the most difficult part of running the project in your school?

Air Quality Workshop

There was no single overriding difficulty in running the air quality workshop in the schools. However, individual teachers mentioned problems as follows: Getting release time for teachers and students; getting student volunteers; motivating the students; finding time for the teachers to do the project in the school; space in the school; money for equipment; and adapting the project to fit the course.

There was one case of a teacher not doing the project.

Water Quality Workshop

No major difficulty. Individual responses were: Getting release time for teachers and students to attend the workshop was a difficulty within the school; motivating the students and getting student volunteers; and getting equipment and instructions for teachers.

Twice, no real difficulty was encountered by the teachers.

Solid Waste Workshop

The major problem of running the solid waste workshop in the school was soliciting personnel for monitoring. Seven teachers reported that getting volunteer students was a problem and five times, motivating students to monitor was reported as a problem.

The teachers could not be sure the students actually did the monitoring and, this was identified as a difficulty, three times.

There were two cases where the parents were a problem for a period of time.

Also mentioned was taking time for the teachers and the students out of the regular curriculum to do the solid waste activities.

In four cases, no difficulty in running the project in the school was reported.

II. SCIENCE PROJECTS AND THE PROBLEM APPROACH IN INSTRUCTION

Let's consider the problem-approach to teaching which usually means using a problem situation (local conflict which is known to students) as a vehicle for your teaching. Let's also consider science projects which may be student-designed and run, and usually involve small groups of students studying a problem, collecting and analyzing the data and reaching some conclusion.

12. Since the workshop, have you increased your use of environmental problems or projects in your classroom teaching?

    a. Seldom use the problem-approach
    b. No increase
    c. Increased use (Probe)

Response to a. - Six teachers indicated that they seldom used the problem-approach, yet they did choose to attend the workshop.

Response to b. - No increase in the problem project approach, was expressed by 16 teachers.

It may be noted, however, that nine of these respondents stated they already used the problem project approach and there was no increase per se.

Response to c. - Increased use was reported nine times.

The experience and ideas gained by participation helped increase the use of the problem/project approach according to six teachers.

There were five cases where the problem and projects techniques were integrated directly into the curriculum, using the techniques developed and offered by the UWGB workshops.

Other teachers commented favorably on the use of environmental problems, land-use problems and changing from traditional teaching methods.

13. If you have increased your use of problems in teaching, are these of local origin and importance, or are they primarily from text materials?

Fifteen of the respondents indicated that the problems and projects implemented by the students were of local origin.

There were four cases in which the problem/project approach was limited to the use of the BSCS materials.

Five teachers mentioned a 50-50 distribution of problem/project approach and "traditional" teaching methods.

One teacher mentioned seventy-five percent use of text materials, and twenty-five percent use of local materials when doing problem/project approach.

Five teachers mentioned they did not use the problem/project approach.

The use of another text for problem/project approach materials was given as a response three times.

14. Does the study of environmental problems help or hinder your students in meeting your objectives?

a. Helps
b. Hinders
c. Makes no difference

Response to a. - It helps meeting their objectives, was given 26 times.

Response to b. - Hinders their objectives, was given only once.

Response to c. - Makes no difference, was offered as a response four times.

15. Has the use of environmental problems led to increased contact with other teachers and disciplines (such as social studies, art, shop)? How?

a. Yes, increased contact
b. No change
c. Other

Response to a. - Yes, increased contact was reported by ten teachers, and two reported somewhat of an increase.

Response to b. - There were seventeen respondents reporting no change in contact with other teachers and disciplines.

Increased contact between science and social studies people was most often mentioned relative to environmental problems.

Response to c. - Examples of short term contact were as follows: Math teachers aiding in statistical analyses and the use of computers, shop teachers working in the development of monitoring equipment and general discussion with other science teachers.

Three teachers reported ongoing contact with teachers in many areas.

16. To what extent have resource people outside the school been involved in these projects and classes?

a. Not at all
b. Occasionally
c. Frequently

Response to a. - Not at all or very small use of outside resources was reported eight times.

Response to b. - Occasionally, was given as a response seventeen times.

Response to c. - Frequently, was given six times.

Examples of resource people outside the school often contacted and involved in environmental projects and classes included legislators, game wardens, parents, various public officials, the people from Project ICE (a regional enviornmental education project), DNR, people from the paper institute, sewage treatment people, foresters, personnel from UWGB and other universities.

17. Has project activity led to any new courses or revised curricula? Describe.

In seven cases, new courses were developed emphasizing the problem/project approach to teaching. These courses such as environmental monitoring, resource development, environmental seminar, etc., are the interdisciplinary courses described as Case 3 and Case 4 examples on the level II analysis.

In six cases, the teacher expanded the curriculum to include more of the problem/project type work. This involved the implementation of the UWGB-developed workshop techniques.

There were, in three cases, some problem/project emphasis in advanced discipline courses.

Two schools stated they plan a new course which would make use of the problem/project approach, but at the time of the interview they did not have this course in operation.

Twelve teachers reported no new courses or revised curricula attributable to project activity.

18. Are science projects primarily run as a part of classes or as separate out-of-class activities?

a. Run as a part of class (Name classes)
b. Run separately
c. Run both ways
d. Essentially no projects (Go to Question 22)

Response to a. - Run as a part of class was given eighteen times.

Response to b. - Run separately was given seven times.

Response to c. - Run both ways was given once.

Response to d. - Essentially no projects, was given four times.

The range of course titles was as follows: Earth Science, The Watershed, Social Problems, Environmental Monitoring, Science Seminar, Biology, Chemistry, Physics, Advanced Biology, Advanced Chemistry, Resource Development, Environmental Studies, Man In His Environment, Environmental Education, Environmental Seminar, Social Problems, American History, Problems of Democracy and American Government.

19. Describe your science projects.

a. On the average, how many science projects are run in your school each year?
b. At what grade level do most projects occur?
c. What kind of projects have been developed?
d. What prompted their development?

Response to a. - The standard courses as well as the relatively new interdisciplinary problem-focused courses, included six to twelve projects per class section.

Response to b. - There was a wide variety of responses ranging from Grades 9 through 12.

Grades 11 and 12 did the most creditable project work. Grades 9 and 10 may be involved in projects, but the work is not of the caliber of those of Grades 11 and 12.

Response to c. - Problems and projects have been grouped into the following subject areas:

Surveys
- Plants
- Animals
- Microorganisms

Pollution
- Snow residue
- Water quality (10)
- Assorted monitoring (4)
- Solid waste
- Thermal pollution
- Effects of detergents, fertilization and farmland

Population Studies (3)
- Genetic distributions (3)

Historical Projects
- Salmon fishing industry in Kewaunee (Film)
- Mining history in Wisconsin (Granite)
- History of town (Wausau)

Land Use
- Designed nature area (2)
- Reforestation (2)
- Game management (2)
- Resort and recreation impact
- Billboard advertising (2)

19. (Continued)

Biological
- Nutrient effects on plant growth (2)
- Nutrient effects on animal growth (3)
- Animal behavior (4)
- Natural foods

Chemical
- Quantitative analysis (3)

Geological
- Fossil study
- Rock structure study

Response to d. - In the majority of cases (13), it was the teacher's philosophy that prompted the development of science projects.

In four cases projects were an outgrowth of class discussions. Student interest prompted the development of science projects in ten of the cases. The UWGB Mobile Center For the Study of the Environment and the High School Environmental Education Council were also given credit for the development of science projects.

Journal articles were given as a source of project and laboratory exercises.

Student interest and instructor's philosophy go hand in hand. If the instructor is interested in doing projects, then students are interested in doing projects.

20. Consider the science projects run in your school.

a. To what extent do students initiate and design their own projects?
   1. Not at all
   2. Usually
   3. Frequently

b. How do students start a project?

c. Who helps them design the project?

d. Whom do they contact?

e. Do you permit the students to go off the school grounds to collect data?

Response to a. 1. - The extent to which students initiate and design their own projects.

Not at all, was given four times. Somewhere between not at all and usually, was given 13 times.

Response to a. 2. - Usually, was offered four times.

Response to a. 3. - Frequently, was given six times.

In the majority of the cases where students play a small role in initiating and designing their own projects, the courses are single discipline in nature and do not emphasize problem/project approach.

Interdisciplinary problem-focus courses encourage the initiation and design of projects as part of the course. In these courses students frequently initiate and design their own projects.

Response to b. - Origin of student initiation of projects were reported as follows:

Prompted by class discussions and research, ten cases.

Independent interest and study outside of class, five cases.

Prompted by need for extra credit, three cases.

Suggestion from teacher, eight cases.

Printed materials, one case

Response to c. - Help with the design of the project was reported as follows:

The immediate teacher was the resource person in 21 cases.

Other faculty in the department were involved in seven cases.

20. (Continued)

The students, themselves, in five cases, were totally responsible for the design of the project.

Faculty outside the department, library personnel and assistance from college students working in this area were each given as responses one time.

Response to d. - Other contacts:

The immediate teacher and "outside agencies" were each mentioned twelve times.

Other faculty within the department, i.e. Science Department were mentioned in ten responses.

UWGB and other college's assistance was mentioned in three cases.

Other faculty outside the science department were mentioned twice.

Response to e. - Data collection off campus.

In all cases students were free to collect data off campus. In fact, in 17 cases, class time was allowed; in 9 cases, school free time was allowed; and in 3 cases, no school time at all was allowed.

21. How have your science projects changed since your participation in the UW workshop?

Seventeen respondents reported change in science projects as follows: An increase in number of projects (7 cases); improved techniques (4 cases); environmental influence (4 cases); and more local emphasis (2 cases). Fourteen teachers indicated little or no change.

22. To what extent does your school administration support project activity?

a. To a great extent
b. Somewhat
c. Lack of support

Response to a. - To a great extent, was reported seventeen times.

Response to b. - Somewhat, was given ten times.

Response to c. - Three respondents indicated low levels of support but emphasized that this was different than a lack of support.

23. How do you evaluate student's participation in science projects?

In most cases (14), there was an overall, rather subjective inspection of the project by the teacher. The teacher, after observing student input and output on the project, would assign a grade. An additional four teachers emphasized attitude and accomplishment which is closely related to subjective inspection of project mentioned previously.

24. Time

a. To what extent is teacher time a limiting factor in the development of new science projects?
   1. A great limiting factor
   2. A moderate limiting factor
   3. Not a significant limiting factor

b. To what extent is student time a limiting factor in the development of new science projects?
   1. A great limiting factor
   2. A moderate limiting factor
   3. Not a significant limiting factor

Response to a. 1. - Teacher time: A great limiting factor - 24 cases.

Response to a. 2. - A moderate limiting factor - 4 cases.

Response to a. 3. - Not a significant limiting factor - 2 cases.

Response to b. 1. - Student time: A great limiting factor - 14 cases

Response to b. 2. - A moderate limiting factor - 5 cases.

Response to b. 3. - Not a significant limiting factor - 8 cases.

It was noted that students who participate in science projects are usually considered better students, active in many other extracurricular activities and so have limited time to be spent on science projects.

The problem of busing also limits students' time for working on science projects. In rural communities the buses leave immediately after school.

Also, many students would rather work after school and earn money than spend the same time working on school science projects.

25. In what ways does the study of environmental problems affect student interest in science?

a. Increase
b. Decrease
c. No difference

Response to a. - An increase in student interest in science was reported twenty-two times.

Response to b. - A decrease in student interest was mentioned only once.

Response to c. - No difference in student interest was given six times.

Teachers reported that the use of local environmental problems tends to motivate the student.

26. In what ways does the study of environmental problems affect student learning in science?

a. Increase
b. Decrease
c. No difference

This question was supplemented with the statement, given equal amounts of time, does more learning occur through the study of environmental problems, or studying science from a more "traditional" teaching strategy?

Response to a. - There was an increase in student learning through the study of environmental problems, as opposed to the more traditional science study. This response was given twenty-three times. One teacher indicated "somewhat of an increase."

Response to b. - No teachers indicated a decrease in learning.

Response to c. - No difference was given as a response five times.

It was said that environmental problems are more realistic and relevant to students. This motivating force supplies increased interest and results in increased learning.

The teachers indicated that such problem work is appropriate in some areas but not all teaching areas lend themselves to such an approach.

27. Have you found adequate teaching materials and activities dealing with environmental problems and science projects?

a. Yes
b. No

Response to a. - Yes, was given sixteen times.

Response to b. - No, was given thirteen times.

Seven teachers stated there were more teaching materials and activities than can be kept track of. There was a call for a clearinghouse of environmental science activities to make them more easily accessible to the teachers.

Four teachers stated they haven't really looked.

Three teachers reported that they develop their own problems and projects and, therefore, haven't looked for teaching materials or activities dealing with environmental science problems.

Legitimate use of these environmental teaching materials and activities was a concern voiced by four teachers.

28. In what ways has contact with the University been useful in your efforts to change your instructional program?

Contact with the University resulted in changes in the instructional program for all but seven of the teachers. The changes included: Expanding the instructional to include environmental concerns and problems (10 cases), strengthening philosophy of science for the program (4 cases), and improved techniques and resources (5 cases).

29. Do you feel a need for--

a. More workshops for teachers and students
b. Materials and guides for science projects
c. Problem-oriented instructional materials for use in classes

---

Response to a. - Twenty-six teachers expressed need for more workshops. Only two said no. It was mentioned, however, that a repeat of a workshop was not sufficient. They needed new ideas, methods and materials.

Response to b. - Twenty-four teachers stated yes, two stated not more but did suggest a clearinghouse to coordinate these materials and guides. Two respondents said there was no need for materials and guides for science projects.

Response to c. - Twenty-two respondents stated there was a need for problem-oriented instructional materials. One respondent stated that he was developing his own materials as a part of a course.

Eight teachers suggested the materials be designed for a class of thirty students. Two teachers said BSCS problem-oriented instructional materials were already available. Two said there is no need for problem-oriented instructional materials for use in classes.

III. BACKGROUND INFORMATION

Size of School
Grades in Building
Changes or Trends in Enrollment in Science Classes

Size of School	No. of Schools
less than 500	3
500-1000	6
1000-1500	5
1501-	4

Grades in Building	No. of Schools
9-12	12
10-12	5
11-12	1

Changes or Trends in Enrollment in Science Classes

Generally speaking, Biology enrollment is constant and the course is often required; Chemistry and Physics enrollments are going down. There is a great upward trend, however, in science courses such as Agriculture, Conservation, and Resource Utilization. There is also an upward trend in higher level interdisciplinary problem-focused courses such as Environmental Monitoring, Environmental Education, Man and His Environment, Environmental Seminar, etc.

uwgb

UNIVERSITY OF WISCONSIN-GREEN BAY
NATIONAL SCIENCE FOUNDATION
PROJECT #EPP74-20276

High School Environmental Science Project

I. Directions

Take your blue answer sheet. Turn it sideways so the name block is at your right. In the boxes at the top of the block, fill in the letters in your name (last name, first name, and middle initial). Then fill in the spaces for the letters in the boxes in each column. If there are not enough boxes for the letters in your name, just fill in as many as you can.

At the top of the answer sheet, where it says "School" and "Instructor," fill in the name of your school, city and the teacher for the class in which you are filling out the answer sheet. Do not complete any other blocks.

II. Below is a list of areas in which you might take courses in school. Indicate how you feel about taking courses in each area. Even if you have not had any courses in an area, indicate how you think you feel about the area. Mark your answers in Section I of the answer sheet, in the spaces for Items 1 - 10. Mark: 1 for LIKE; 2 for NOT SURE; or 3 for DISLIKE on your answer sheet.

		1 LIKE	2 NOT SURE	3 DISLIKE
1.	Art	1	2	3
2.	Music	1	2	3
3.	English	1	2	3
4.	Science	1	2	3
5.	Business	1	2	3
6.	Mathematics	1	2	3
7.	Home Economics	1	2	3
8.	Social Studies	1	2	3
9.	Foreign Language	1	2	3
10.	Industrial Arts (Shop)	1	2	3

III. Read each statement below. For each statement, decide whether you agree, disagree, or are not sure if the statement is true for you. On your answer sheet, in Section I, beginning with Item 11, mark: 1 for AGREE; 2 for NOT SURE, or 3 for DISAGREE.

		1 AGREE	2 NOT SURE	3 DISAGREE
11.	I would rather be an engineer than a doctor.	1	2	3
12.	I prefer fiction to non-fiction books.	1	2	3
13.	I like games which involve solving problems.	1	2	3
14.	I like to work crossword puzzles.	1	2	3
15.	I'm as good at solving puzzles as most of my friends.	1	2	3
16.	I am challenged by situations which I don't immediately understand.	1	2	3
17.	I'd rather play games which are just fun than ones which make you think.	1	2	3
18.	I find it easier to understand charts and graphs by reading about them than by looking at them.	1	2	3
19.	For me, the most important thing about a job is the opportunity to do independent thinking.	1	2	3
20.	I would rather have someone tell me the solution to a problem than have to work it out myself.	1	2	3

IV. Read each question and the answer choices. Select your answer. Mark the number for your answer on the answer sheet. Use the spaces for Items 21-35 in Section I of the Answer Sheet.

21. Which of these is most difficult to recycle?
    (1) soup cans
    (2) beer bottles
    (3) milk cartons
    (4) newspapers

22. The greatest difficulty in selecting an acceptable sanitary landfill site is:
    (1) danger of leakage into the ground water
    (2) presence of rats and flies
    (3) ugliness of exposed refuse
    (4) danger of epidemics

23. Which of these is least likely to decay and become part of the natural environment:
    (1) aluminum cans
    (2) chicken bones
    (3) paper plates
    (4) steel cans

24. The process of allowing organic wastes to decompose into soil humus is known as:
    (1) filtration
    (2) oxygen regeneration
    (3) composting
    (4) ecosystem replenishment

25. The process of spreading and compacting solid wastes, then covering it with earth is known as:
    (1) open dumping
    (2) sanitary landfilling
    (3) dredging
    (4) clean incineration

26. Solid waste is everyone's problem. On the average, each person in this country produces about how many pounds of solid waste every day?
    (1) 1/6 lb.
    (2) 6 lbs.
    (3) 26 lbs.
    (4) 66 lbs.

27. The amount of solid waste we produce is--
    (1) not changing
    (2) slowly decreasing
    (3) rapidly decreasing
    (4) increasing

28. Solid waste is a problem--
    (1) only for the big cities
    (2) only for the developed countries
    (3) that has developed only in the last few years
    (4) that has been around for hundreds of years

29. Burning solid wastes in an incinerator--
    (1) permanently destroys the chemical elements of most materials except for ashes and clinkers;
    (2) solves a major pollution problem without creating other major problems;
    (3) is probably the dirtiest way to deal with solid wastes;
    (4) changes most of the solids to gases and discharges them into the air.

NAME: _____ SCHOOL: _____

VI. WRITE AS MANY QUESTIONS AS YOU CAN ABOUT AIR QUALITY.

For any topic or object we can think of many questions which might be asked. Some of the questions might be of special interest to you and some of special interest for other people. Some of the questions might be rather simple and ordinary, while some others might be quite unusual. In the spaces below, write as many questions as you can think of about air quality. Write each question on a separate line. You will have 5 minutes to write your questions.

(Use the other side if you need it.)

30. Most of the cost of disposing of solid waste comes from--
    (1) maintaining a dump site
    (2) collecting and transporting the solid waste
    (3) cost of fuel used in the incinerator
    (4) purchasing land for the dump site

31. Which is true of solid waste?
    (1) It contains valuable material that could be reused.
    (2) It should be dumped into the ocean.
    (3) It is junk that no longer has any use.
    (4) It should be burned.

32. Sanitary landfill sites--
    (1) almost always prevent other future uses of the land;
    (2) are dangerous to the health of a community;
    (3) can be used for parks or golf courses after dumping is completed;
    (4) must be located many miles from a city to limit odors.

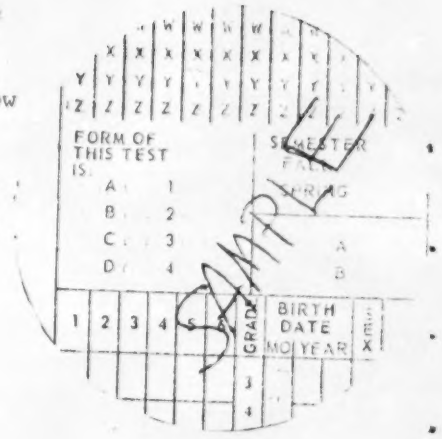
33. When solid wastes are burned, the heat produced--
    (1) comes from the natural gas used to fire the incinerator;
    (2) is so slight as to be neither harmful nor useful;
    (3) pollutes the atmosphere;
    (4) could be used to generate electricity.

34. Disposing of solid waste is usually the responsibility of what level of government?
    (1) federal
    (2) state
    (3) county
    (4) local

35. Which of these has <u>not</u> contributed to an increasing problem in dealing with solid waste?
    (1) new methods of packaging
    (2) recycling of goods
    (3) population growth
    (4) planned obsolescence of goods.

(Turn to next page, Section V)

V. Look through the list of Career Categories below. Decide what your first, second, and third choices for a career are. Write these numbers in the boxes at the top of the columns labeled 1, 2, 3, 4, 5, and 6, in the section below the name block on your answer sheet. (See Sample.) Write the number of your first choice in the boxes labeled 1 and 2; the number for your second choice in 3 and 4; and the number for your third choice in the boxes labeled 5 and 6. Then fill in the spaces below each box for the number you put in the boxes.



CAREER CHOICES

Arts, Humanities

01 Arts-Painting, Ceramics, Jewelry, Sculpture
02 Commercial Art-Illustration
03 Dramatics-Theatre/Acting
04 Fashion Design/Modeling Sewing
05 Graphic Arts/Printing
06 Music
07 Photography

Communications

08 Computers-Data Processing
09 Journalism-Newspapers/Writing
10 Telephone-Installation/Operator/Service
11 Television/Radio

Construction Trades

12 Air Conditioning/Refrigeration
13 Carpentry/Woodworking
14 Electrician
15 Machinist
16 Mason/Brick Layer
17 Plumber
18 Sheet Metal/Welding/Flame Cutting
19 Foundry & Metal Casting

Technology, Engineering & Architecture

20 Architecture/Drafting/Mechanical Drawing
21 Construction
22 Engineering-Civil, Mechanical
23 Electrical Engineering
24 Landscape Design/Horticulture
25 Paper Making Technology
26 Printing Trades

Transportation

27 Aviation Careers
28 Trucking Careers
29 Railroad Careers

Business, Commerce & Administration

30 Accounting/CPA/Bookkeeping
31 Advertising & Public Relations
32 Banking & Finance
33 Business Management
34 Hotel/Restaurant Management
35 Insurance Business
36 Marketing & Purchasing
37 Personnel Management
38 Stockbroker/Investment
39 Sales Management/Salesmanship
40 Secretarial/Clerical Careers
41 Small Business Operation
42 Travel Agent

Environmental Management & Control

43 Water & Air quality
44 Environmental Planning

Environmental Sciences

45 Astronomy
46 Chemistry/Physics/Biology
47 Conservation/Game Management
48 Ecology/Forestry
49 Environmental Science/Earth Science/Geology
50 Mathematics
51 Meteorology/Weather Forecasting
52 Oceanography

Recreation

53 Charter Boat Operation
54 Horsemanship
55 Recreation Planning
56 Summer Sports/Camping/Hiking
57 Water Sports/Boating/Sailing
58 Winter Sports/Snowmobiling/Skiing
59 Golf

AgriBusiness & Food Production

60 Farming/Milk/Beef/Pork/Grain Production
61 Farm Products-Milk-Cheese Processing & Marketing
62 Food Processing/Distributing/selling

Social Services

63 Child Care
64 Clergy/Religion/Religious Education
65 Coaching/Recreation
66 Counseling/Vocational Guidance/Human Relations
67 Health Education
68 Nursing Home/Care of the Elderly
69 Physical Education
70 Professional Youth Leadership
71 Social Services/Sociology
72 Teaching/Elementary School
73 Teaching/High School
74 Teaching/Special Education

Services

75 Auto Repair/Mechanics/Body Work
76 Food Management/Cooking/Chef
77 Hair Styling/Cosmetology
78 Home Economist/Homemaking
79 Interior Decorating
80 Mortician

Law & Government

81 Community Planning
82 Fire Fighting/Rescue
83 Government/Local, City Management
84 Law-Lawyer
85 Military/Armed Services
86 Police and Law Enforcement

Health Sciences

87 Dentistry/Dental Technician
88 Doctor of Medicine
89 Hospital Administration
90 Medical Technician/X-Ray/Lab Technician
91 Nursing/Nurses Aid/Practical Nursing
92 Nutrition
93 Optometry
94 Paramedics & Allied Health
95 Pharmacy
96 Psychology
97 Speech Therapy
98 Therapy/Physical/Occupational/Recreational
99 Veterinary Medicine

If you plan to go to college after high school, mark Square A in the block above the birth date block.

If you plan to go to Vocational-Technical School, mark Square B.

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UNIVERSITY OF WISCONSIN-GREEN BAY
NATIONAL SCIENCE FOUNDATION
PROJECT #EPP74-26276
POST TEST

High School Environmental Science Project

I. Directions

Take your blue answer sheet. Turn it sideways so the name block is at your right. In the boxes at the top of the block, fill in the letters in your name (last name, first name, and middle initial). Then fill in the spaces for the letters in the boxes in each column. If there are not enough boxes for the letters in your name, just fill in as many as you can. Please use a pencil with soft dark lead, such as No. 2.

At the top of the answer sheet, where it says "School" and "Instructor," fill in the name of your school, city and the teacher for the class in which you are filling out the answer sheet. Do not complete any other blocks.

II. Below is a list of areas in which you might take courses in school. Indicate how you feel about taking courses in each area. Even if you have not had any courses in an area, indicate how you think you feel about the area. Mark your answers in Section I of the answer sheet, in the spaces for Items 1 - 10. Mark: 1 for LIKE; 2 for NOT SURE; or 3 for DISLIKE on your answer sheet.

	1 LIKE	2 NOT SURE	3 DISLIKE
1. Art	1	2	3
2. Music	1	2	3
3. English	1	2	3
4. Science	1	2	3
5. Business	1	2	3
6. Mathematics	1	2	3
7. Home Economics	1	2	3
8. Social Studies	1	2	3
9. Foreign Language	1	2	3
10. Industrial Arts (Shop)	1	2	3

III. Read each statement below. For each statement, decide whether you agree, disagree, or are not sure if the statement is true for you. On your answer sheet, in Section I, beginning with Item 11, mark: 1 for AGREE; 2 for NOT SURE, or 3 for DISAGREE.

	1 AGREE	2 NOT SURE	3 DISAGREE
11. I would rather be an engineer than a doctor.	1	2	3
12. I prefer fiction to non-fiction books.	1	2	3
13. I like games which involve solving problems.	1	2	3
14. I like to work crossword puzzles.	1	2	3
15. I'm as good at solving puzzles as most of my friends.	1	2	3
16. I am challenged by situations which I don't immediately understand.	1	2	3
17. I'd rather play games which are just fun than ones which make you think.	1	2	3
18. I find it easier to understand charts and graphs by reading about them than by looking at them.	1	2	3
19. For me, the most important thing about a job is the opportunity to do independent thinking.	1	2	3
20. I would rather have someone tell me the solution to a problem than have to work it out myself.	1	2	3

(Please turn to next page)

IV. Read each question and the answer choices. Select your answer. Mark the number for your answer on the Answer Sheet. Use the spaces for Items 21-35 in Section I of your Answer Sheet.

21. When the materials are recovered from solid waste, we say they are--
(1) expensive
(2) weakened
(3) remined
(4) recycled

22. The water that seeps through the solid waste in a dump or land fill--
(1) may pollute the local drinking water
(2) helps to keep the dump sanitary
(3) is used to make the solid waste settle
(4) creates heavy fog conditions

23. About half of the weight of American household solid waste consists of--
(1) furnace ash
(2) metal cans
(3) food waste
(4) paper and paper products

24. Solid waste problems will be solved by--
(1) using less science and technology
(2) making better use of science and technology
(3) passing rigid laws to stop solid waste
(4) eliminating present laws regarding solid waste

25. Sanitary landfill is--
(1) soil that has had the solid waste removed
(2) a dump where waste is covered with soil
(3) the soil used to cover sewer pipe
(4) the only fill that can be used around a house

26. Which of these sources yields the greatest amount of solid waste yearly in the United States--
(1) animal manure and crop wastes
(2) mineral solid waste
(3) industrial wastes
(4) household, commercial and municipal wastes

27. Which of these is the most important cause underlying our solid waste problems--
(1) the replacement of coal-burning furnaces with gas and electric furnaces
(2) higher incomes leading to greater production of consumer products
(3) increased dumping of fertilizers into streams
(4) increased use of salt on the highways

28. Which is not an example of a solid waste--
(1) untreated sewage
(2) metal cans
(3) plastic wrappers
(4) old newspapers

NAME:_____ SCHOOL:_____

VII. WRITE AS MANY QUESTIONS AS YOU CAN ABOUT:

ENERGY USES IN YOUR COMMUNITY

For any topic or object, we can think of many questions which might be asked. Some of the questions might be of special interest to you and some of special interest for other people. Some of the questions might be rather simple and ordinary, while some others might be quite unusual. In the spaces below, write as many questions as you can think of about energy uses in your community. Write each question on a separate line. You will have 5 minutes to write your questions.

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(Use the other side if you need it)

29. The two chief methods of disposing of municipal solid wastes are--
    (1) landfill disposal and incineration
    (2) physical and chemical decomposition
    (3) incineration and water dispersal
    (4) composting and ocean dumping

30. Which of these is the most serious drawback of home garbage grinders in sinks--
    (1) excess use of water
    (2) loss of revenue for municipal solid waste collection agencies
    (3) danger of electrical malfunction
    (4) overloading of municipal sewage disposal systems

31. Which solid waste disposal practice is most likely to require cooperation between and among nations--
    (1) international landfill sites
    (2) dumping solid waste into the ocean
    (3) waste heat utilization from incinerators
    (4) open dumping in underdeveloped nations

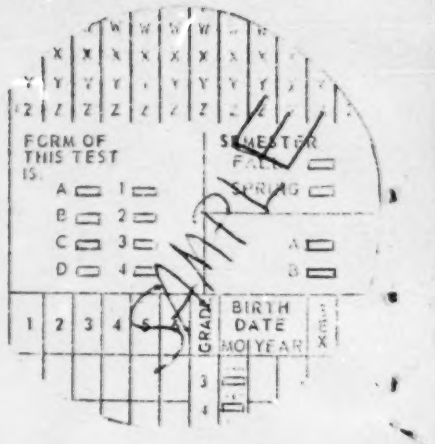
32. Filled sanitary landfill sites are most commonly used for--
    (1) farming
    (2) dumps
    (3) recreational sites
    (4) heavy construction

33. Solid waste control programs in the past have usually centered on--
    (1) limiting the production of solid waste
    (2) controlling the type of waste produced
    (3) enacting laws to replace wasteful products with reusable products
    (4) salvaging materials when economically feasible

34. The use of incinerators for disposing of solid wastes was brought about by--
    (1) the growth of large cities
    (2) the need to safely dispose of hazardous wastes
    (3) the danger of overloading the sewage system
    (4) the need to dispose of wastes in towns not located near a body of water

35. Solid waste contains materials which--
    (1) have become almost worthless
    (2) are some of our most valuable resources
    (3) will never be needed again
    (4) cannot be used again

(Turn to next page, Section V)



V. Plans for continuing education after high school--

If you plan to go to college, mark Square A in the block above the birth date block.

If you plan to go to vocational-technical school, mark Square B.

VI. Career Plans--

Look through the list of Career Choices below. Decide what your first, second and third choices for a career are. Write these numbers in the boxes at the top of the columns labeled 1, 2, 3, 4, 5 and 6, in the section below the name block on your Answer Sheet. (See Sample.) Write the number of your first choice in the boxes labeled 1 and 2; the number for your second choice in the boxes labeled 3 and 4; and the number for your third choice in the boxes labeled 5 and 6. Then fill in the spaces below each box for the number you put in the boxes.

CAREER CHOICES

Arts, Humanities

01 Arts-Painting, Ceramics, Jewelry, Sculpture
02 Commercial Art-Illustration
03 Dramatics-Theatre/Acting
04 Fashion Design/Modeling Sewing
05 Graphic Arts/Printing
06 Music
07 Photography

Communications

8 Computers-Data Processing
9 Journalism-Newspapers/Writing
10 Telephone-Installation/Operator/Service
11 Television/Radio

Construction Trades

12 Air Conditioning/Refrigeration
13 Carpentry/Woodworking
14 Electrician
15 Machinist
16 Mason/Brick Layer
17 Plumber
18 Sheet Metal/Welding/Flame Cutting
19 Foundry & Metal Casting

Technology, Engineering & Architecture

20 Architecture/Drafting/Mechanical Drawing
21 Construction
22 Engineering-Civil, Mechanical
23 Electrical Engineering
24 Landscape Design/Horticulture
25 Paper Making Technology
26 Printing Trades

Transportation

27 Aviation Careers
28 Trucking Careers
29 Railroad Careers

Business, Commerce & Administration

30 Accounting/CPA/Bookkeeping
31 Advertising & Public Relations
32 Banking & Finance
33 Business Management
34 Hotel/Restaurant Management
35 Insurance Business
36 Marketing & Purchasing
37 Personnel Management
38 Stockbroker/Investment
39 Sales Management/Salesmanship
40 Secretarial/Clerical Careers
41 Small Business Operation
42 Travel Agent

Environmental Management & Control

43 Water & Air quality
44 Environmental Planning

Environmental Sciences

45 Astronomy
46 Chemistry/Physics/Biology
47 Conservation/Game Management
48 Ecology/Forestry
49 Environmental Science/Earth Science/Geology
50 Mathematics
51 Meteorology/Weather Forecasting
52 Oceanography

Recreation

53 Charter Boat Operation
54 Horsemanship
55 Recreation Planning
56 Summer Sports/Camping/Hiking
57 Water Sports/Boating/Sailing
58 Winter Sports/Snowmobiling/Skiing
59 Golf

AgriBusiness & Food Production

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92 Nutrition
93 Optometry
94 Paramedics & Allied Health
95 Pharmacy
96 Psychology
97 Speech Therapy
98 Therapy/Physical/Occupational/Recreational
99 Veterinary Medicine